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ROYAL BOTANIC GARDENS, KEW

XXV—THE SECRETION OF A BITTER SUBSTANCE IN THE GENUS INULA.

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In a previous paper (Politis, 1932) I have reported the presence of glands in *Cynara Scolymus* Pers. (artichoke) and *Cynara Cardunculus* L., which secrete a bitter substance and an essential oil at the same time. The glands arise among the hairs and consist of a round head of 4–5 two-celled stories attached directly to the epidermis. The bitter substance is secreted by the two terminal stories and collects under the cuticle. If treated with osmic acid it turns black, with tincture of alkanna it becomes red, and with Sudan III brick-red. The secretion dissolves completely in acetic acid, alcohol or ether.

Continuing my study of the secretion of bitter substances in the *Compositae*, I have observed the presence of certain glands in *Inula graveolens* Desf., *I. attica* Hal., and *I. viscosa* L., which differ morphologically from those that Tschirsh (1889) and Tunmann (1900) reported from other species of this family.

In *Inula graveolens* the glands occur on the stem, leaves, sepals and pedicels, making the plant sticky, fragrant and bitter. The roots, petals and seeds, as well as the tissues underneath the epidermis, where these glands are lacking, are devoid of the above characteristics.

An examination of material gathered about the middle of June revealed the presence of long, septate hairs on the stem, on both sides of the young and mature leaves and on the outer surface of the bracts. These hairs consist of a few-celled conical support bearing a row of three or four thick-walled cells, of which the terminal one is long and pointed, whilst those nearer to the support are shorter and broader. These thick-walled cells bulge at their points of attachment, and may easily be detached. The cells of the stalk remain short and are filled with protoplasm, whilst those of the hair proper become elongated, thick-walled and filled with air.

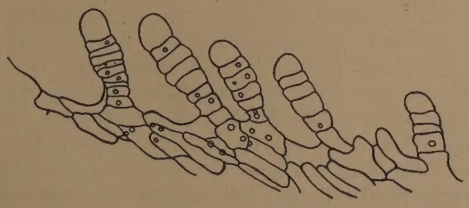

Fig. 1. Young leaf glands of *Inula graveolens*, × 380.

Glands, consisting of a stalk and a head, are situated amongst the hairs. The gland stalks are built up of one or two rows of thin-walled cells, the lower of which are broad and long whilst those close to the head attachment are relatively short. The heads are ellipsoidal in shape and consist of four to six many-celled stories ; the terminal secretory story is built up of two or four cells sharply differentiated by the nature of their contents.

The secretion collected under the cuticle of the secreting cells of the mature glands strongly refracts the light ; it is colourless to begin with but later becomes yellowish and then brown-yellow. This colour is retained when the secretion spreads on the surface of old leaves after rupture of the cuticle.

The development of the gland starts with the protrusion of an epidermical cell, which, after elongating somewhat, becomes divided transversely into a number of cells. The lower of these constitute the stalk but the upper are destined by enlargement and perpendicular divisions to become the many-celled glandular head, the terminal cell forming the secreting storey by dividing into two by a perpendicular wall, or into four by two perpendicular walls at right angles to each other.

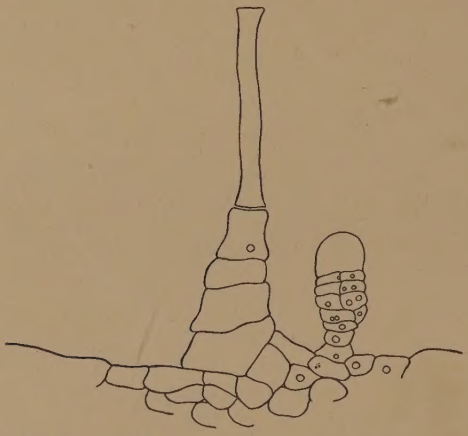

Fig. 2. Leaf gland of *Inula graveolens* situated close to a portion of a hair, × 380.

The glands of the leaf margin have uniseriate stalks ; those on the upper and lower surfaces of the leaf are biseriate. Not all of the cells of the gland have the same contents. Thus, besides the usual inclusions, the cells of the stalk contain spherical bodies which strongly refract the light and are devoid of chlorophyll ; the secreting cells are also devoid of chlorophyll but contain particles and rods which are darkly stained if treated with iodine solution. The remaining cells of the head contain chlorophyll and spherical bodies.

Microchemical examination shows that the secretion dissolves in alcohol, ether or chloroform; with tincture of alkanna it is coloured red, with Sudan III it becomes brick-red and with osmic acid blackish. These reactions indicate the presence in the gland secretion of an essential oil which is the cause of the characteristic fragrance of the aerial parts of the plant. The addition of concentrated sulphuric acid causes the secretion to become yellow, and the cuticle to rupture quickly. If treated with sulphuric acid the cell sap of the head cells also becomes yellow.

Concentrated hydrochloric acid colours the sap of the head cells yellow, causing them later on to turn brown-yellow and then brown. If 20 per cent. potassium hydroxide is allowed to react on a freehand section under the coverglass, the sap of the gland cells, the epidermis and the hair with its support assume a dark-yellow colour. If an aqueous solution of iron trichloride is used instead, the sap of all the above cells becomes green. The last two reactions with potassium hydroxide and iron trichloride are due to flavonic compounds whose presence can also be determined by applying the reducing method of Shibata (1915) to leaf extracts.

As already stated, I have observed certain spherical bodies in the cells of the gland. Similar bodies are also present in the epidermal and mesophyll cells. These become red with alkanna tincture, brown with osmic acid and brick-red with Sudan III. If the sections are left for 24 hours in a 20 per cent. aqueous solution of potassium hydroxide the bodies remain insoluble, but ether or chloroform dissolves them completely.

In *Inula attica* I have also observed that those parts such as the flowers or young shoots and leaves which are covered with glands and hairs have a bitter taste, which, however, is lacking from tissues such as those of the fleshy receptacle or from beneath those parts of the epidermis on which glands are absent.

Among the hairs, which are 3–4-celled, we find glands with a large head and usually a short stalk. The stalk, however, is sometimes absent and other glands composed of a long stalk and a small ellipsoidal head also occur.

The glands with a short stalk and a large head produce a large amount of secretion which is at first colourless but later turns yellowish and then brown. The glands with a small head and a long neck either produce a very little colourless secretion or none at all. Of the glands found in the ray florets, the greatest number are situated on the outer portion of the rays. On the outer surface of the corolla of the unopened disc florets there is another kind of club-shaped gland consisting of several two-celled stories; the two terminal secreting cells, which are devoid of chlorophyll, are longer and filled with protoplasm.

As in the previous species, *I. attica* not only tastes bitter but is also fragrant; this is due to an essential oil secreted under the cuticle at the same time as the bitter substance.

The glands of the third species I have studied, *I. viscosa*, are similar to those of *Inula graveolens* except that they do not produce a bitter secretion. They are found on the stem, leaves and flowers. An examination of these parts reveals the presence of a great number of hairs with the same structure as those of *I. graveolens* and among them glands which consist of a head attached to the epidermis by means of a one- or two-rowed conical stalk. The head is ellipsoidal in shape and is built up of 5 few-celled stories, the last being the secreting storey and usually consisting of four cells which, unlike the other head cells which have already been described,

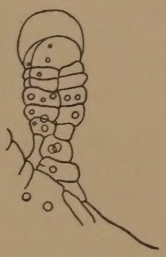

Fig. 3. Leaf gland of *Inula viscosa*, × 380.

do not contain chlorophyll and droplets of oil. The cells of the stalk are also devoid of chlorophyll but contain tiny oil droplets. The secretion from young glands found on young leaves and stems, which is collected under the raised cuticle of the secreting storey, is at first colourless but becomes yellow and finally brown. It dissolves in alcohol, chloroform or ether; it is stained red with Sudan III and in general possesses the microchemical reactions of the essential oils.

REFERENCES.

1. POLITIS, J., 1932. "Sur la présence de glandes sécrétant des principes amers dans Cynara scolymus Pers.", in *Prakt. de l'Acad. d'Athènes*, **7**, 31.

2. SHIBATA, K, 1915. "Untersuchungen über das Vorkommen und die physiologische Bedeutung der Flavonderivata in den Pflanzen," in *Bot. Mag. Tokyo*, **29**, 118.

3. TSCHIRCH, A., 1889. "Angewandte Pflanzenanatomie," 465.

4. TUNMAN, O., 1900. "Ueber die Sekretdrüsen," **27**.

XXVI—PRINCIPLES OF PLANT GEOGRAPHY.*

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INTRODUCTION.

Plant-life, so far as we know, is limited, with few exceptions, to what is usually termed the surface of the earth, that is, to the narrow layer where atmosphere and lithosphere or atmosphere and hydrosphere meet. Roots and soil organisms penetrate some feet into

* The basis of three lectures given at Westfield College, University of London, February 1939.

the subsoil, the tallest trees grow upwards a few hundred feet, while spores and some bacteria may float at higher levels, but beyond a few thousand feet at most probably never again function. Even in the ocean, holophytic plants are limited to the depth of penetration of sunlight (that is, to the photic region which is said to extend to a depth of 40 m.), and in the lower depths only parasitic or saprophytic bacteria and fungi can live. The biosphere is thus very shallow but it is practically co-extensive with the surface of the earth. To say that the study of the distribution of organisms over this area is biogeography and that of plants is plant geography, phytogeography, or geobotany provides a definition which may leave a wrong impression because of its conciseness. The plant geographer is not content merely with knowing the existing ranges of the different kinds of plants: he wants to know the underlying causes and particularly the history behind the existing distribution. His outlook is as dynamic as that of the student of ecological succession or of taxonomic evolution. Facts have, of course, to be collected, analyzed, classified, and understood statically, i.e., in themselves, before they can be explained (in a scientific sense) but such labour is a preliminary to obtaining an insight into geological succession and even into the processes of evolution, and is not an end in itself.

The aims of the student of plant geography can be stated briefly as:

1. The determination of the geographical distribution of taxonomic units, of which the species is the most generally important.
2. The determination of the geographical distribution of plant communities.
3. The relating of such distributions to the environmental factors, past and present, and to the evolutionary history of the taxonomic unit or plant community.
4. The correlation one with another of all the facts thus obtained and their expression in the form of a description of the flora and vegetation of the earth on a geographical basis.

Complaint may be made that this is a programme of too wide a scope. It is true that a very wide range of facts has to be considered in phytogeographical studies. For many of these, however, the phytogeographer has to rely on specialists. Thus, outside the realm of biology, geological, physiographic, meteorological, and historical effects may be phytogeographical causes. Within the realm of biology, the results of many detailed ecological and genetical researches have to be incorporated and taxonomy is the very foundation of plant geography.

There have been various attempts made to summarize our knowledge of the distribution of the plant-life of the whole earth and some of these will be discussed later. Most phytogeographical research, however, is concerned either with a limited area, larger or smaller, or with a taxonomic unit. The methods used may be concisely stated thus:

1. An examination of the physical features of the area and of their possible influence in extending or limiting distribution.

2. A study of the geology and soils and of the geological history of the area.

3. A consideration of all meteorological data of the area, including palaeometeorology.

4. An analysis of the human history in the area and its effect in modifying the flora and vegetation.

5. A listing of all the species known for the area, with their exact distribution in the area, and the following particulars concerning them: their duration, life-form, flowering period, habitat range, altitudinal range, and distribution outside the area (if any).

6. An investigation of the plant communities, including their floristic composition and their distribution.

7. A summary of what is known regarding the plant succession.

8. A review of the cultivated crops and methods of agriculture, horticulture, and forestry.

When data have been accumulated under these heads it should be possible to tabulate, map, and synthesize the general floristic and vegetational features of the area. The actual range of the species is the best unit to use in this synthesis, though the intermediate steps and possible types of classification are numerous. In the course of grouping the data together it is possible, within limits, to determine the probable lines of migration, the centres of species formation, the relative importance of external factors controlling the flora and vegetation, and the outstanding features of the plant-life and its history, and finally to make a well-established phytogeographical division of the area into regions, provinces, etc. On the applied side such a completed survey is invaluable as a guide to the development of agriculture, horticulture, and forestry.

In practice, the data are not collected in the above, or any other, definite sequence. A system of card-indexing and loose-leaf filing has to be gradually evolved to meet the needs of the research. It is most important to remember that no fact bearing even indirectly on the plant-life must be neglected and that pre-conceived notions of how the species or vegetation ought to behave must be rigidly suppressed. Thus, in filing the preliminary data of distribution the exact localities must be listed on a purely positional basis and not on any classification of the area into supposed biogeographical, climatic, or even physiographic divisions. The geographical ideal is to use the lines of latitude and longitude. This is sometimes possible but unfortunately the shape of some areas makes the land content relative to the water content of divisions so bounded extremely unequal. Again, in a large area stretching a considerable distance in a north to south direction, such divisions decrease significantly in size in a north or south direction from the equator. Another disadvantage of lines of latitude and longitude is that the exact areas they enclose are

difficult to memorize and it is easy to make errors in placing localities in them. Usually some compromise with political divisions, from the size of countries or departments to that of vice-counties, is found most practicable for the preliminary arrangement of the facts.

Factors influencing the Distribution of Plants.

A. *Factors influencing the distribution of plant communities (vegetation).*

The relationship between phytogeography and ecology is so close that no sharp line can be drawn between them. In general terms, one may say that phytogeography is extensive and ecology intensive, though each can use many of the data provided by the other. From our present standpoint we must be prepared to profit by the conclusions of ecologists, whenever they are available, for an area to be studied phytogeographically. A convenient, but never absolute, division of ecology is into autecology, the household affairs of one species, and synecology, the grouping of species into communities. Autecology is naturally a floristic factor to the student of plant geography and we shall consider its importance later. For the moment we are concerned with synecology, *i.e.*, with the study of plant communities.

Ecology is, in its modern form, a young and rapidly growing branch of biology. It follows that not only is our knowledge of plant communities very unequal for different countries but also that the time has not yet arrived when a relatively final nomenclature and classification of communities on a world-wide basis can be accepted by general agreement. Two main tendencies can be recognized in the attempts of ecologists to classify communities: the first involves the use of what may be termed general physiognomy and existing analytical characters, and the second the use of succession as the basis. The former is exemplified by Rübel's work on "Pflanzengesellschaften der Erde," and the latter by Clements's "Plant Succession."

Rübel, in his presumably final scheme, 1930, has nine primary, twenty-seven secondary, and a very large number of subordinate classes. To the primary and secondary classes Latin names are given, and the primary classes are:—

Pluviilignosa (rain-forest and rain-brushwood).
Laurilignosa (laurel-leaved forest and laurel-leaved brushwood).
Durilignosa (hard-leaved forest and hard-leaved brushwood).
Ericilignosa (heath-brushwood).
Aestilignosa (summer-green forest and summer-green brushwood).
Hiemilignosa (forests and brushwoods green in the rainy, often monsoon, periods).
Aciculilignosa (coniferous forests and brushwoods).
Herbosa (a very diverse agglomeration of more or less closed communities dominated by non-woody species).

Deserta (used in a wide sense to include all open communities with low water supply).

Phytoplankton is scarcely more than mentioned, but, strangely, is classified under Deserta, possibly by error.

Rübel's work is an enlargement, with some modifications, of an earlier publication by Brockmann-Jerosch and Rübel. An excellent critical review and summary of this by A. G. Tansley will be found in Journ. Ecol. **1**, 27 (1913).

Clements's scheme of plant succession is now so well known that only a brief reference to it will be necessary. It is based on development, compared closely with the development of an organism, and thus takes up a dynamic standpoint resulting in some respects in a classification very different from that based on a single static character, such as physiognomy, or a small number of such characters. The vegetation is divided into " climax " and " seral " units, a climax community itself—the adult organism—is called the " formation," while the entire successional series leading up to a climax is termed a " sere." A very adequate summary of Clements's book " Plant Succession " is given by Tansley in Journ. Ecol. **4**, 198 (1916).

It is interesting to note that since both physiognomy, in Rübel's sense, and the climax, in Clements's sense, depend on the basic cause of climate, there is a considerable amount of agreement in the actual delimitation of certain communities, especially those dominated by woody vegetation. The greatest disagreement is in the classification of herbaceous communities relative to one another and to the woody communities.

The classification adopted by the plant-geographer must partly depend on the amount and nature of ecological research done in the area with which he is concerned. For many areas, he must, at present, use more than one system adapted to his own needs, but there is an increasing tendency to place emphasis on succession whenever possible, without, however, accepting Clements's extreme theoretical conception of vegetation being an " organism."

There have been, perhaps, more disputes about the definition and classification of habitats than about most other matters of ecological concern. The concept of habitat is critically and analytically examined by Yapp in Journ. Ecol. **10**, 1 (1922). Here, again, the phytogeographer must follow the ecologist and, for any given area, must base the scheme he uses for habitat classification on results obtained by detailed research, to the extent that this is available. He can, however, sometimes simplify or otherwise modify a purely ecological classification to suit his own needs. Often he has to combine the results of several authors, and such a synthesis may be no easy task.

In the broader view taken by the phytogeographer, as compared with the more intensive research of the ecologist, climatic factors are more important than edaphic or biotic. The zonation of the earth as

given in elementary text-books of geography into tropical, temperate, and frigid zones, is based on temperature, and, since it ignores the precipitation factor, is only roughly correlated with the distribution of plant communities. The phytogeographer soon realizes that no factor acts independently in controlling the distribution of either communities or species. Brockmann-Jerosch (Engl. Bot. Jahrb. **49,** Beibl. 109, 19 : 1923), has emphasized the importance of considering all climatic factors as forming a " Klimacharakter." I have however, pointed out (Turrill, 1931), that it is necessary to extend this conception of interaction of factors to include not only all climatic factors, but also edaphic, biotic, and historic factors. Moreover, Liebig's law of the minimum for plant growth can be extended to survival or flourishing in an ecological or phytogeographical sense. Yet plant distribution depends more on temperature and precipitation than on all other factors of the environmental group (i.e., factors external to the plant itself), and more so if one includes the relict effects of past climates and the effects of climate on soil development.

To illustrate the predominating influence of climate on the distribution of plant communities we may consider their distribution in the Balkan Peninsula. In this area two main climatic regions meet. These are the Mediterranean and the Central European. The former has relatively hot dry summers and maximum rainfall in a mild winter ; the latter has much colder winters and rainfall distributed with greater equality through all the seasons. It is particularly the seasonal distribution of rainfall, i.e., its distribution relative to mean monthly temperatures which is so striking and which obviously has a predominant effect on the distribution of both communities and species. In the Mediterranean Region the summer is too dry for the full development of perennial summer " soft-leaved " plants, unless these have special internal adaptations or are limited to very local and specifically favourable habitats. Drought is the limiting factor and, in general, only xerophytic types of vegetation can be summer-green. Hence the predominance in the climax communities of evergreen sclerophylls such as *Pinus halepensis*, *P. Pinea*, *Quercus Ilex*, *Q. coccifera*, *Arbutus Unedo*, *A. Andrachne*, *Myrtus communis*, *Olea europaea* var. *oleaster*, *Rhamnus Alaternus*, *Smilax aspera*, *Calycotome* spp., *Juniperus Oxycedrus*, etc. (see Turrill 1929 and 1937). In the seral communities similarly the constituent plants are xeromorphic, wilt-surviving, or drought-avoiding. Thus many species have dense hairy or waxy coverings, exhale ethereal oils, or have small and often rolled leaves, or they limit their vegetative period to coincide with the rains and are geophytic in the summer. The lush vegetative growth and abundant florifery of the macchie in the spring (with a secondary development in the autumn) contrasts with its period of relative rest from July to September inclusive. On the other hand, in the Central European

Botanical Region it is winter cold, and not drought at any season, that is the limiting factor—the main sieve that determines what shall naturally survive. We find therefore in this region that deciduous forests are the normal climax and that the plants associated with the summer-green trees and also those of the seral communities are for the most part mesophytes. Vegetation commences its annual growth in the spring and usually continues to develop till the lowering of night temperatures causes a slowing down. There are, of course, local (especially altitudinal) or temporal exceptions to these generalizations but in the long run they have little effect on the characteristic vegetational types.

It is interesting to refer here to another phenomenon which shows the influence of climate on the distribution of vegetational types. Reference has been made to the Mediterranean climate and its close correlation with marked types of vegetation. It is significant that wherever a similar type of climate occurs, in any part of the world, plant communities with a similar physiognomy, and sometimes with the same genera, also form the vegetational climaxes. Thus, sclerophyllous forests and brushwoods occur in the Mediterranean Basin (macchie), in California (broad-sclerophyll forest and chaparral), in Chile, in south-west Australia, and in south-west Africa. At Kew, some years ago, a rather striking exhibit illustrating these communities was prepared and an account of it will be found in Journ. Ecol. **16,** 178 (1928). The closest comparison can be drawn between the sclerophyllous woods and the macchie of the Mediterranean Basin and the corresponding communities in California (see Cooper 1922). It is particularly interesting that in both areas species of *Quercus*, *Myrtus*, *Arbutus*, *Rhamnus*, and *Cercis* occur, while *Laurus nobilis* L. of the Mediterranean is represented in California by *Umbellularia californica* Nutt. of the same family. There are important floristic differences as well as these resemblances but in what may be termed " ecological characters " the communities are strikingly alike.

The distribution of tropical rain-forests, of coniferous woods, of desert communities, of tundra, of steppes, and of many other types of vegetation could similarly be shown to be dependent in the main on climate. Yet edaphic, biotic, and what may be termed historic factors, can, as has been well shown by Salisbury (1926), modify and cause variations in both climax and seral communities within one climatic region. The converse also holds, and, for example, under different climates we may find in Europe certain plant communities at their north-western limits definitely calcicolous, while at their south-eastern limits they are either indifferent to calcareous and non-calcareous soils or prefer the non-calcareous.

It is desirable here to emphasize one important group of factors, loosely called the historic, which are frequently ignored by ecologists. We saw above that in parts of the world widely separated in latitude and longitude similar climatic conditions, in our example

that of the Mediterranean type of climate, control the development of types of vegetation having a generally similar facies. These sometimes show a limited number of floristic resemblances, but for the most part the species composing the communities are different in the different areas. The floristic difference between two such communities gives a measure of the historic difference between them. Species can only be selected by climate, or by any other factor, if the species are there to be selected and from this standpoint the composition and distribution of communities depends on the distribution of species for which, as we shall see later, the historic factors are of great importance.

Zonation on a small scale has been much studied ecologically. One can see examples at the margins of ponds, lakes, and rivers, on the sea-coast, at the edge of woodlands, and so on. On a large scale there are climatic zonations, and usually on an intermediate scale there is altitudinal zonation. Altitude is neither a simple factor nor a factor in itself. With increasing altitude one finds such factors as temperature, precipitation, insolation, and exposure change and it is changes in the climatic factors especially which can be correlated with changes in the vegetation. We find, therefore, lowland, hill, and high mountain climaxes and seres, arranged in a series of belts, narrow where the altitude increases rapidly and broader where the contours are wider apart. There are mountain masses where altitudinal zonation is not only very clear and obvious but relatively regular, though most often it is irregular because of the interference of such factors as great physiographic irregularity, great variations in rock outcrop, natural denudation, and interference by man. For temperate and tropical regions the general sequence of plant communities is from broad-leaved climax forests of the lowlands, through various forest belts of the hill and lower high mountain zones, to high mountain brushwood, to high mountain herbaceous communities, and finally to permanent ice and snow. Such a sequence may be truncated at any stage according to the altitude reached by the mountains. There is, ecologically, an undoubted general resemblance between altitudinal zonation and that shown in progression from the tropics polewards, but the details show great differences, especially because of differences in the floristic composition of the communities.

Brockmann-Jerosch (1919) has published an important account of the limits of tree growth both at high altitudes and at high latitudes. He rightly emphasizes the complex sum total of factorial and especially of climatic action and the control exercised by any factor which is at or near a minimal value for any life function. He finds there is no single extreme factor causing the tree limit; it is caused by one or another of the sum total of factors attaining, at any one altitude or latitude, a value below that at which trees can exist. There is here, then, an interesting example of the same effect having at different places

different causes. The factors interacting include mountain mass, temperature, precipitation, duration of snow-free period, wind, and, locally, soil conditions. On the whole, the higher the mountain massif the higher is the tree limit, in approximately the same latitude. Exposure, especially north contrasted with south exposure as on two sides of an east-and-west orientated valley, also influences not only the tree-limit but also that of most altitudinal zones. Thus in the Balkan Peninsula the forest limit is higher in the larger and higher Rodope Massif than it is on the Suva Planina, on the Stara Planina, or on the Vitoša. Again, the forest is more luxuriant, and closed forest ascends higher, on the northern than on the southern slopes of the Stara Planina and the Rodope Massif. In South America, the east and west sides of the Andes differ most strikingly in climate and vegetation.

High altitudes have another important phytogeographical feature. Migration of both communities and species may take place on approximately the same level, north, south, east, and west, but it may also be up and down to the limits of tolerance. Frequently there may be a combination of change in latitude or longitude coupled with a change in altitude. Thus we find in the Balkan Peninsula a Central European type of vegetation comes farther south in the mountains of the Pindus and Rodope than it would if the country were entirely plain and hill-land. On the other hand, the Mediterranean flora and even plant communities push northwards along the flat or low coasts and inland up such river valleys as those of the Vardar, Narenta, and Maritsa.

Reference must be made to the use of cultivated crops in phytogeographical surveys. These are often valuable indicators of the natural conditions. In highly cultivated countries they usually occupy a considerable proportion of the ground surface as fields, gardens, or plantations. Further, the most important crop plants have been cultivated in such countries often for long periods. There has, therefore, been a selection which, though artificial and different in many ways from, has been as rigid in action as natural selection. Man has, in the long run, to depend on his crops for maintenance and therefore he soon discards those that do not flourish under conditions which, though modified by the human activities summed up in the word " cultivation," are still mainly controlled by nature. The cultivation of the olive is quite a good criterion of a typical Mediterranean climate. Even within the British Isles wheat does better in the east than in the west and will not ripen on a commercial scale in the north (see Messer, 1932).

The important Russian work on the origin, dispersal, and present distribution of cultivated crops is well worth the attention of the student primarily interested in the distribution of wild species and vegetation. Vavilov (1926) sums up the enormous amount of detailed research carried out largely by himself and his Russian colleagues and reaches conclusions of wide general interest. He points out that

methods similar to those used by phytogeographers are applicable to cultivated plants. Thus, in order to establish the place or places of origin of cultispecies, the geographical ranges of all their varieties and the areas of concentration of varieties, what is known directly of their history in earlier times, the cytogenetics of the varieties, the range of related species (wild and cultivated), and the relationship of the species and varieties to parasites must be ascertained. In general, Vavilov holds that regions showing maximum diversity, and generally having a series of endemic varieties and characters, will usually be the centres of origin. He recognizes five principal centres of origin for the most important field and garden crops: 1. S.W. Asia; 2. S.E. Asia; 3. The Mediterranean Basin; 4. Abyssinia; 5. Mexico and Peru with the adjoining mountainous countries.

Space will not allow of more than a very brief mention of the more important of the most clearly defined plant communities. In the tropics we have: the tropical rain-forest, the most lush and highly developed of all plant communities, developed under the most favourable conditions for plant growth—constant high temperature and a plentiful supply of moisture at all seasons of the year; the monsoon forests, with periodic growth periods and intermittent periods of complete or relative rest; savannah types with an open tree community and mixed shrubby and herbaceous vegetation between. In the subtropics we have the great desert regions of very low rainfall and high day temperatures. In the warm temperate regions there are local developments of temperate rain-forest and extensive areas of evergreen sclerophyllous forests and brushwoods. In the temperate regions summer-green, winter-deciduous forests, prairie and steppe grasslands, and moor and heath communities in the broadest sense are the chief types of vegetation. In the cooler temperate areas coniferous forests often form the climax. In the Arctic, Subarctic, and Subantarctic various forms of tundra predominate.

In such a list only a few of the communities have been named and those in the broadest terms. It is, however, clear that the general structure of these communities and their distribution depends on climate.

B. *Factors influencing the distribution of taxonomic units (flora).*

In utilizing ecological data the plant geographer has either to adopt ecological methods, terminology, etc., or to accept data, when these are available, provided by the ecologist. In the floristic analysis of an area, however, he is on his own ground. This is the more evident when it is acknowledged that a phytogeographer should be his own taxonomist and decide for himself the limits he accepts for the taxonomic units he uses. The species, in spite of all the difficulties of "species problems," must, for practical reasons, form the starting point of floristic studies. Taxonomy

is the very basis of all biological studies and though this is rather more obvious in phytogeography than in other branches of biology it is also true for morphology, ecology, genetics, cytology, and even physiology. Unless the organisms investigated are known so that their kind can be not only recognized again and again but can also be determined and preserved in such a way that the information can be passed on to contemporary and future biologists, published research work on any phase of their life-history may be not only useless but even misleading. A taxonomist sometimes wonders just what value to place on, say, some cytological research when he finds that there has been no checking of determinations or filing of herbarium specimens. This is not to slur over the difficulties of taxonomic research but to emphasize its very great importance. Modern taxonomy is attracting an increasing attention partly because it is widening its own basis to include a much greater range of both observational and experimental research and partly because taxonomists themselves are realizing the need of explaining the value of their results to their biological colleagues. The recently formed Association for the Study of Systematics in Relation to General Biology is proving of great value in both these respects.

With all its faults the hierarchical system of classifying organisms into families, genera, species, etc., has greater general practical value than any other so far proposed. Other systems for special purposes are not only desirable but often essential and an indefinite number of such can be made and used to advantage more or less within the framework of orthodox taxonomy. These are, however, nearly always either based on the species concept or refer to this as a standard. To explain adequately the species concept and to discuss fully the problems of species would take us too far from our central subject. The following criteria have been found to work well in practice : a species is morphologically definable in that it has a sum-total of characters, and every individual within it has constant resemblances with every other individual within it, and constant differences from every individual of other species, even when the individuals are grown under diverse conditions ; species are more or less isolated one from another, sometimes geographically, sometimes by habitat preferences, sometimes by having different flowering periods, usually by not crossing naturally to produce completely fertile offspring ; species may show differences in chromosome morphology and behaviour. A species is an isolated group of individuals whose sum of characters tends to keep constant by natural in-breeding. In applying these criteria it has to be remembered that there is nothing absolute about them. The taxonomist, not nature, decides what groupings of individuals shall be called species and in this sense species are artificial scientific conveniencies. Abstracting on the basis of the above criteria the taxonomist finds that he can learn, and enable his colleagues in other branches of biology to learn,

more about organisms than would be possible by any other known method. Isolation is very diverse in kind, degree, and cause. The emphasis on morphological resemblances and differences is justifiable because of the relative ease with which they are determinable and with which they can be preserved in type or standard specimens and also because they are nearly always correlated with physiological differences. The actual delimitation given to species is frequently a matter solely of scientific convenience, possibly more so in plants than in animals, because in the plant kingdom isolation is less complete and less permanent, owing to such barriers among animals as psychological preferences in mating. With taxonomic groups higher than species, morphological criteria are usually the only ones used, though again, these often have a high degree of correlation with physiological characters. Yet even for genera and families it is often found that there is both a high degree of coherence of a number of characters and a limitation of " tendencies " within the group. The possibility of explaining these by phylogenetic theories is, within limits, taxonomically legitimate.

One word of warning must be given. No taxonomic classification must be based on criteria which it is intended later to deduce from an analysis of such a classification. This is a particular danger in phytogeographical studies and it is essential always to guard against it by a rigid application of the principles of morphological resemblances and differences and the coherence of attributes (see Turrill 1925, 1938).

The above interpolation has been necessary because of the complete dependence of phytogeography on taxonomy. Before the range of a species, genus, or family can be investigated the unit itself must be defined. This being done its exact geographical distribution must be listed. For graphic representation the range may be mapped in such a manner that it can be compared with the range of other species and with the distribution of the environmental factors. There are many methods of mapping distribution. Localities must be first listed, one by one. If, on the scale used, distribution is " discontinuous " dots, circles, or crosses can be put on the map, if " continuous " then shading, ringing round or blacking out can be used to indicate the range. The nature of the " blank " map must depend on scale, size, and aims. Usually only such physiographic details should be present as are necessary to determine localities with accuracy and ease. Separate maps must be used for correlation of range with physiographic, geological, meteorological, and other features of the area. The use of transparent paper for range map reproduction has much in its favour since opaque maps can be placed underneath and numerous correlations easily seen (compare Messer, 1932).

When listing and mapping of ranges are completed they form the basis for determination of the relative importance of factors

as causes of existing distribution and also the floristic basis for phytogeographical divisions. Examples may now be given under a number of convenient headings.

Physiographic. Distribution is limited by the occurrence of such physiographic barriers as seas, high mountain ranges, and extensive plains. While it is true that by seed dispersal mechanisms such barriers may sometimes be crossed they are none the less effective in limiting range in proportion to their size or area ; their past effectiveness also depending on their age and history. Thus in spite of climatic similarities resulting in tropical rain-forest in the Congo and Amazon basins, the floras are totally distinct. Even the proportion of common genera is low and common species are almost non-existent. Islands like St. Helena, the Hawaiian Islands, and even the Canaries or Crete have very many endemic species. Mountain ranges are highways for the migration of mountain species but barriers for lowland species. The nature of the altitudinal barrier is, as mentioned earlier, largely analyzable into climatic factors but it is usually convenient to consider it additional to climate. The Pyrenees form a very effective barrier to Spanish species, many of which would presumably have a much more extensive northern range did the mountina barrier not exist. The Dinaric Alps limit the eastern spread of Mediterranean species in the western parts of the Balkan Peninsula to a narrow coastal belt. On the other hand, the plain of the south of France prevents many Pyrenean species extending into the Alps, and the physical discontinuities of many of the Cretan and Greek mountains has led to the isolated distributions of many species, valleys and plains acting as barriers to their spread.

Climatic. As with plant communities so with plant species, climate is the major factor in the limitation of their ranges, at least for the seed-bearing plants. Temperature, precipitation, and length of day are the most important climatic factors. Tropical species cannot stand frost, and many temperate species do not flourish and reproduce under tropical temperatures, even apart from competition. Even for the British Isles, the Southern, Mediterranean, Atlantic, Northern, and other elements show, on the whole, a definite correlation with climate as the work of Stapf, Salisbury, and Matthews has demonstrated. Striking examples of climatic limitations may be found on contrasting species of the Central European with species of the Mediterranean flora. Thus *Isopyrum thalictroides* L. is typically Central European, while *Arbutus Unedo* L. is Mediterranean. Deserts may be regarded as essentially both climatic barriers and highways of the most striking and effective kind and the factor in them controlling plant distribution is absence or lowness of rainfall. Irrigate a desert and it will generally "blossom like a rose." Desert species all show adaptations, morphological and/or physiological, to the extreme external conditions. On the negative side

they are often species which do not like competition with closed vegetation. The distributions of species of *Cactaceae* in the semi-desert regions of America or of succulent species of *Euphorbia* in those of southern Africa illustrate the limitation of species by this combination of factors with drought as the basic cause. The limitation of species in Western Australia is largely accounted for by the boundaries of the desert belt. The occurrence of Mediterranean species and genera in the Sahara is only possible by the occurrence of oases and mountain ranges with water supply. Recent research, however, shows that this penetration or relict survival is much more extensive than was formerly supposed and extends farther to the south than had been realized.

The relative length of daylight has been shown by Garner and Allard and by many others to be an important factor in controlling flowering and since this is naturally dependent on latitude it is one factor controlling plant distribution since it sets barriers to spread north or south (see Allard, 1932 and Garner, 1937).

Edaphic. Soil factors, in the broadest sense, limit species, within a climatic zone. It should also be remembered that, according to the now widely accepted conclusions of the Russian school of pedologists, climate is a major factor in the evolution of the climax type of soil. This should obviously be best demonstrated in extensive continental areas which are subjected to the effects of markedly regular weather conditions and which have had a long unchanged geological history. For such areas as the British Isles, for mountainous regions, and locally probably for all districts, the nature of the parent rock must play an important part sufficient to disturb or modify soil zonation on a climatic basis, if only because the climax type of soil cannot be found *in situ* continuously over wide areas.

It has frequently been pointed out that soil factors, in the widest sense, act as limitations to species distribution through either their physical or their chemical effects on plants. Even the character pair calcareous and non-calcareous may have this dual action as shown by Salisbury (1920). The relatively local extent of soil distribution is the reason why a considerable number of species pairs can be listed whose relative distributional differences are correlated with different soil preferences. Examples are :—

Calcicoles : *Gentiana Clusii* Perr. et Song., *Primula Auricula* L., *Anemone alpina* L., *Lithospermum purpureocaeruleum* L., *Rhododendron hirsutum* L., and *Achillea atrata* L.

Calcifuges : *Gentiana Kochiana* Perr. et Song., *Primula viscosa* Wulf., *Anemone sulphurea* L., *Lithospermum diffusum* Lag., *L. prostratum* (Lois.), *Rhododendron ferrugineum* L., and *Achillea moschata* Wulf.

Higher water-content : *Alopecurus geniculatus* L., *Stachys palustris* L., *Lotus major* Scop., and *Geum rivale* L.

Lower water-content : *Alopecurus pratensis* L., *Stachys sylvatica* L., *Lotus corniculatus* L., and *Geum urbanum* L.

Triglochin maritimum L. of salt marshes and *T. palustre* L. of fresh-water marshes, in this country, and *Scirpus lacustris* L. of hard waters and *S. Tabernaemontani* Gmel. of brackish waters are other interesting species pairs. *Silene maritima* L. and *S. Cucubalus* Wib. [*S. vulgaris* (Moench) Garcke] are also ecologically separated species in England, with the nature of the substratum as a basically determining factor. Numerous species are limited in south-eastern Europe to serpentine soils (see Turrill 1938).

Biotic. Probably the most important natural biotic "factor," phytogeographically speaking, that limits or aids distribution is competition. It is also the most complicated since it involves the action of a group of factors and is thus difficult to measure. Extensive closed communities, such as a tropical rain-forest or a wide belt of coniferous forest, form a barrier to all species which cannot compete with or survive with the dominants and such a barrier may be as complete as an equal area of sea or high mountains, though it will only be shown on vegetational maps. Again, we know that the stages of succession depend on competition between the dominant species of one stage with those of the preceding and succeeding stages. So that the distribution of seral stages is a factor in the distribution of species. The typical weeds of cultivated, and particularly arable, land are largely early colonizers able to exist only in the absence of close competition with species of a stage nearer the climax. Their often very wide present distribution is due to man providing and maintaining secondary seres only a little above the nudation stage (see above, p. 216).

Whether extensive grassland areas are mainly formed and maintained by herds of animals destroying tree seedlings or whether the herds of animals exist because of the pre-existence of prairies, steppes, and similar communities may be a nice point to argue. Probably cause and effect are here often inextricably mixed and a natural equilibrium occurs only through long continued reciprocal interaction of all the factors of natural selection. To the extent that herbivores maintain grassland (or better, herbland) against forest, they act as biotic factors limiting the distribution of species of forest communities and allowing full extension to those of the herbaceous communities that can withstand grazing. The herds of wild bison of the American prairies have gone, but at least they did not, as man is doing, destroy not only the vegetation but also the very soil. The wild fauna of Africa and of other parts of the world will follow the bison to extinction, unless extensive natural parks be promoted in time and be maintained. A majority of mammals, at least, seemed doomed to extinction or to such reduction in numbers that they cease to be a biogeographical factor, excepting only such as man domesticates or allows to be, or cannot prevent being, parasitic upon his crops or ruderal to him.

Man, indeed, is, with his domestic animals, already the most important of all biotic factors. His influence on vegetation and on

species distribution has been enormous and has increased with increasing human population and scientific invention. I quote from a work published in 1929 (Turrill, 1929, p. 236) : " It has been shown that man has influenced the natural flora of the Balkan Peninsula from very early historic or even prehistoric times, chiefly in a destructive manner. This has been accomplished at the expense of the high woody vegetation and has led to a great extension of brushwood communities and those of stony and rocky ground. This has resulted in the expansion, both in species numbers and in distribution, of many genera suited to such habitats, and a corresponding reduction in the abundance of woodland plants. By draining marshes the marsh and aquatic vegetation has been reduced. New habitats have been provided by agriculture and by the more or less permanent occupation of sites for habitation. Species new to the flora have been introduced by commercial and military activities and some have spread far and wide." How far nature could cure the scars left by civilized man on her fair face, if man were suddenly exterminated, it is difficult to say. Flahault (1937), for the south of France, suggests that it both could and would be done in a relatively short time. I think that, for some areas, it would take thousands of years and might never be absolutely complete.

Historical. Under this heading we may consider all such previous distributions of land and sea, and all such changes of the surface features, including climate, as have occurred in geological time. The subject is a huge one and very controversial. Some of the theories put forward by geologists, such as that of Wegener's movement of the continents and later modifications of the original theory, are undoubtedly important but sometimes raise as many phytogeographical questions as they solve, or leave important ones quite unanswered. On the other hand, such happenings as the Ice Age or the formation of the Aegean Sea are beyond dispute as having occurred so recently that they explain many features of existing distribution of species and communities. The influence of the Ice Age on the British Flora has been discussed a great deal in recent times and it may be well to let the subject rest for a while till more evidence is obtained by the intensive study of single species. We will therefore take the Aegean area as an example of the action of historical factors on species distribution. The geological evidence is conclusive that there was land connexion between Asia Minor and Greece (in the sense of the modern kingdom) from early till geologically recent times. Suess, indeed, suggested that early man may have witnessed the break-up of the Aegean continent and the inrush of the sea over all except the horst-like islands. The break-up occurred earlier in the south and extended northwards. Such a geological history explains the very close floristic connexions between the Balkan Peninsula and Asia Minor. Two main directions of migration may be traced : the one northwards from Asia Minor

to Thrace, South Bulgaria, and Macedonia ; the other westwards from Asia Minor across the Aegean to Crete and Greece. Figures always need careful interpretation or they may give a wrong impression. Excluding widely-spread Mediterranean Basin or Mediterranean Regional species, and also ignoring vicarious endemics, about 700 species of seed-plants show directly this trans-Aegean connexion. Evidence from centres of maximum variation (generic and specific) and from range limitations suggests strongly that the main migration has been westwards though there was certainly some also in the opposite direction. Reference should be made to Turrill (1929), pp. 373–388, for a fuller discussion.

In considering the external factors concerned with the distribution of species it must have become evident that our division under such headings as physiographic, climatic, and so on is largely one of convenience. Though it is possible to pick out one factor as having or having had a predominant influence on existing distribution, that factor is rarely simple in itself and still more rarely unrelated to other factors. As examples of the interaction of factors we may consider the distribution of the common box and of the common beech. In this country both plants are limited to or flourish best in natural communities on calcareous soils. Yet near the south-eastern limits of its range, the box avoids calcareous soils and is an indicator of serpentine outcrops, while the beech is either largely indifferent to the calcareous nature of the soil or prefers not to grow on limestones. Or again, in England the yew likes well drained calcareous slopes, in Bulgaria it prefers damp, even waterlogged, habitats. There are many other examples, most of which require detailed investigation and that before it is too late and man has destroyed the evidence in his exploitation of nature's wealth.

C. *Inherent and miscellaneous factors.*

The endogenous or internal factors which play a part in the distribution of plants are, with few exceptions, either not well understood or their full effect is difficult to estimate with our present knowledge. Nevertheless they open up a fascinating realm for research.

The selective and limiting effects of environmental factors have clearly a very great importance as links in the causal chains of geographical distribution and, combined with what have been called historical factors, have till recently been considered as setting the most important limits to phytogeographical explanation. The rise of cytogenetics has, however, opened up a new field of distributional studies. It is generally recognized that all characters (including distribution) are based on interaction between the genom and the environment (in the widest sense). Research on chromosome numbers, morphology, and behaviour shows that these are, through their gene content and the relative and absolute position of the genes, in the main, the basic endogenous controllers of morphological and physiological characters. Polyploidy, the occurrence of extra

sets of chromosomes, often modifies such characters as compared with those of the normal diploid (Müntzing 1936). As might, therefore, be expected, polyploids sometimes show distributions different from those of the corresponding (presumably ancestral) diploids. The subject is rather in its infancy and generalizations must at present be vague. Tischler (1935) showed that for the two-thirds of the species of Schleswig-Holstein whose chromosome number is known, 60 per cent. of those with a distribution towards the north show polyploidy, while only 27 per cent. of the species with a general southern distribution are polyploid. Rohweder (1936) has shown for the same area that polyploid species rise to as much as 95 per cent. in areas flooded by waters with a high calcium content. Fischer and Schwanitz (1936) have discussed the question in general terms. Hagerup (1932, 1933, 1938) has shown, for a wide range of genera and a variety of localities and habitats, that polyploidy tends to be relatively commoner in extreme than in mesophytic environments and that " with polyploidy there may follow a change in the ecological and plant-geographical value of the plant."

None can dispute that dispersal occurs by means of disseminules, i.e., by spores, fruits, seeds, and organs of vegetative multiplication. Many facts and observations have been recorded (see Ridley, 1930). Unfortunately, for most floras the mechanism of dispersal has been observed in action for only a very low proportion of the species and the relative value of supposed structural adaptations has rarely been determined. Instead there has been a general tendency to describe morphological characters in terms of shape and measurement and to assume that they function effectively in water, wind, or animal dispersal. Certainly the data at present available make any attempt to treat the subject statistically of doubtful value. Many of the widespread species of the European flora, for example, the oaks and the common beech, have no obvious dispersal mechanism and a general study of the subject has convinced me that dispersal mechanisms, though important, can easily have their value over-estimated. Always evaluation must be in relation to all the other factors of the environment and of the plant. Widespread dispersal, as by wind, is extremely wasteful and it is difficult sometimes to see how wind dispersal mechanisms could have been selected by the accepted processes of natural selection. On the other hand, the advantage of water dispersal is obvious for strand, aquatic, and marsh species because of their general adaptation to more specialized conditions. It may also be suggested that dispersal should be studied in connexion with germination. A. S. Watt (1919) has shown for the oak, with immediate germination of the acorns, the need for a humus or soil covering. Another interesting example is in the bladder campions. The common bladder campion (*Silene Cucubalus* Wib.) has its major germination in the spring, but *S. maritima* L. seeds can germinate naturally immediately on ripening, though there is also a second germination period in the spring of

the next year. In the course of experiments with these species Marsden-Jones and I have observed seeds of *S. maritima* L. germinating while held up in the capsules and bladdery calyces attached to the parent plant. It was for long a puzzle how seedlings could establish themselves among the large rounded pebbles of, for example, the Chesil Beach. If the seeds slipped between the pebbles into the lower darkness the epigeal cotyledons could not function and the seedlings must perish. By germination when still held up by the calyces and branches of the plant the radicles could penetrate into the substratum while the cotyledons manufactured food. For dispersal to be successful it must be followed by ecesis (establishment of the plants).

Another matter which phytogeographers must not neglect is seed-setting. Firstly we have the internal and external factors controlling flowering, such as the carbohydrate-nitrogen ratio and photoperiodism, secondly mechanisms of pollination, thirdly environmental control of seed-ripening, and fourthly cytogenetic factors for fertility or its converse sterility. Space will only allow a mention of these, for any detailed examination would take us into physiology, cytogenetics, and entomology. A mere mention of the subjects, however, serves to show how wide an interest can be developed in the study of distribution. The presence of suitable pollinating agents obviously controls the distribution of species. This is particularly well seen in entomophilous species highly adapted to a particular insect visitor. One may refer to the orchids, amongst which such species as *Angraecum sesquipedale* Thou. may well be considered over-adapted. This species has nectary spurs, green and whip-like and of what Darwin calls "astonishing length," up to a foot or more with only the lower $1\frac{1}{2}$ inches filled with nectar. The pollinia cannot be withdrawn naturally till some huge moth with a wonderfully long proboscis tries to drain the last drop. As Darwin says, "if such great moths were to become extinct in Madagascar, assuredly the *Angraecum* would become extinct." This may be an extreme example but there are many other known plants dependent for their distribution on success in attracting one or a limited number of species of insect.

The work of Raunkiaer and others has concentrated attention on the importance of habit and especially on the structural adaptations which permit the survival of plants during the unfavourable season. Raunkiaer's more important papers on this subject are now available in an English translation, and only one example of the application of his method will be given here. His well-known spectrum method by which the flora of an area is expressed in terms of percentage occurrence of the life forms as classified by him, has a very high value. I found it both easy to use and highly illuminating in my studies on the flora of the Balkan Peninsula. Thus, on the basis of the whole known flora, not on a sample, the spectra for Crete and Serbia were :

Crete : MM/1·3 M/2·9 N/4·8 Ch/13·3 H/27·1 G/10·2 HH/2·0 Th/38·3
Serbia : MM/1·7 M/2·8 N/3·4 Ch/11·3 H/46·2 G/9·1 HH/4·7 Th/20·7
Crete is in the Mediterranean Region and Serbia is in the Central European Region, and the spectra show clearly that Crete has a therophytic and Serbia a hemicryptophytic flora. Even in other smaller details the figures are significant. Comparison of these spectra with those given by Raunkiaer for Samos and for Tripoli and Cyrenaica give further proof of the great phytogeographical value of life-form analysis on a comparative basis.

Both phytogeographers and ecologists tend to overlook the importance of plasticity in relation to distribution. The transplant experiments of the British Ecological Society at Potterne have shown how widely even a limited number of common herbs of the British flora vary in regard to their tolerance of different soil conditions and their morphological and physiological reactions to such. Thus *Centaurea nemoralis* Jord. maintains itself with little morphological change on all the five types of soil used in the experiments. *Silene maritima* L., *S. Cucubalus* Wib., *Anthyllis vulneraria* L., and *Fragaria vesca* L. showed significantly different death and survival rates on the different soils. *Plantago major* L. showed very great morphological changes, while *Phleum nodosum* L. and *P. pratense* L. showed great differences in vegetative vigour and in flower production from soil to soil (Marsden-Jones and Turrill, 1938 and earlier references there). If " specific individuality " is shown so markedly in reaction to soil conditions one would expect an even more marked reaction to climatic differences. There is here, again, a wide field of research open to a combination of ecological-taxonomic-phytogeographical attack.

Willis's " Age and Area Theory " must be briefly mentioned. As is generally known, it is based on the thesis that the area occupied by a species in a country depends primarily on the age of the species within that country. Unfortunately, presumably in an attempt to meet criticisms, Willis finally complicated his expression of the rule so that it became quite unworkable. It then read as follows : " The area occupied at any given time, in any given country, by any group of allied species at least ten in number, depends chiefly, so long as conditions remain reasonably constant, upon the ages of the species of that group in that country, but may be enormously modified by the presence of barriers such as seas, rivers, mountains, changes of climate from one region to the next, or other ecological boundaries, and the like, also by the action of man, and by other causes " (Willis, 1922). It seems that such an " expression " leaves nothing to argue about as it is all-inclusive. Those who have attempted to work the Age and Area " rule," including Willis himself, have had to ignore this " expression " and use some one or other statistical method based on known distribution with species (or genera, etc.) as the unit. It is then found (cf. Turrill 1929, pp. 465–472) that " Age and Area sometimes yields conclusions of

phytogeographical value in the study of the flora of a definite area or of the distribution of a particular genus or family. On the other hand, if used without constant reference to the balance of all known factors influencing the distribution of plants, it will, as will any statistical method, give misleading results." The most important criticisms regarding Age and Area, have not been answered and it certainly cannot be regarded as a key to all the problems of distribution. This is neither to disallow it a limited importance nor to refuse acknowledgment of the value of many of the facts recorded by Willis in his papers and in his book.

The evolutionary history of taxonomic units depends largely on the internal constitution of the plants composing the group and to that extent is an endogenous factor in distribution. This subject is, however, so important and so involved that it must be given separate consideration.

R. D'O. Good has synthesized into a " theory of tolerance " the relationship of the internal factors influencing plant distribution to the external (environmental) factors. This theory may be given in his own words as follows : " Each and every plant species is able to exist and reproduce successfully only within a definite range of climatic and edaphic conditions. This range represents the tolerance of the species to external conditions. The tolerance of any species is a specific character subject to the laws and processes of organic evolution in the same way as its morphological characters, but the two are not necessarily linked. . . . . The relative distribution of species with similar ranges of tolerance is finally determined by the result of the competition between them. The tolerance of any larger taxonomic unit is the sum of the tolerance of its constituent species." Good's paper is worthy of careful study, for, though open to criticism in some details, it indicates the close connexion between phytogeography and what may be termed " species physiology."

In the course of dispersal which results in extended or modified distribution, the gene content of species frequently changes or the species as a whole may become so changed as to cause the recognition by the systematist of one or more distinct geographical subspecies or even species. Sometimes, perhaps not infrequently, extension of range means the loss of genes in that part of the species which reaches farthest from the dispersal centre. For example, in the British Isles several species are much less polymorphic and are much more clear-cut from their congeners than they are farther to the south, and especially south-east of the British Isles. Such a condition we find in *Silene Cucubalus* Wib. and *Ajuga Chamaepitys* (L.) Schreb. (Turrill, 1934). Some examples of this kind can probably be called major clines (Huxley, 1938) and they are closely comparable to what Vavilov records for cultivated crops (1926). There is a great need for analytical research by methods which would combine investigation, on the same material, on tolerance and clinal variation (in the broadest sense).

The geological history of the earth shows that changes are constantly proceeding everywhere. Some are very slow and almost imperceptible, others are more obvious. In the past such changes have frequently been accompanied by or have even been due to meteorological changes whose study is a matter of extreme difficulty. It follows that the existing distribution of plants has behind it a history whose study falls within the province of the phytogeographer, though conclusions based on geological (including palaeometeorological) data have always to be drawn with caution.

The study of fossil floras shows conclusively that what are designated species and other taxonomic units die out, and that others arise to take their place. The methods of evolution of species, genera, families, etc., no doubt have been and are complex. On the whole, phytogeographical studies support the thesis that natural selection acting on mutations is a most important basis. Groups can, however, only be accepted as distinct species if some form of isolation occurs to separate populations in which there are already different genes or between which gene differences can increase. Thus phytogeographical studies can often throw considerable light on species formation by indicating examples of all degrees of isolation. There appear also to be examples of populations diverging as wholes so rapidly that some form of relative mass change seems probable. The term hamogenesis has been suggested for this. Examples occur in the genus *Colchicum* and in *Abies*.

Vicarious species are particularly instructive to study. These are species inhabiting contiguous but not (or scarcely) overlapping areas. Vicarism may be altitudinal or geographical. In Crete and Greece there are a considerable number of high mountain species limited to a small area, sometimes to a single mountain, and yet closely related in morphological characters to species occupying the lowlands and with ranges more or less in juxtaposition. The latter usually have a much wider distribution and the inference of *in situ* development of the high mountain species seems justified on a number of lines of evidence.

The question as to whether species originate in more than one place independently (polytopism) or always arise in one locality (monotopism) or at more than one time (polychronism) is difficult to answer. Species that are morphologically and genetically little, if anything, more than varieties, such as *Fraxinus Pallisae* Wilmott, may well have arisen polytopically, as may those which have arisen through hybridization. On the other hand, a large number of species have probably arisen by gradual differentiation following the accumulation of small mutations after some kind of isolation of a population. The chances of parallelism in such isolated populations is proportionally less the greater the number of differential characters common to members of the species. Polytopism should only be accepted after a very full investigation of all

relevant facts. It may be remarked here that the whole problem of " parallelism " of characters needs re-investigation.

There is no doubt that migration of species has occurred on a large scale in many parts of the world. Such migration can often be traced after a very careful mapping of the distribution of the species and genera of a flora and a consideration of all the known historical facts. We have already referred to migrational lines across the Aegean. Another very interesting line is from the Alps south-eastwards along the Dinaric Alps. The Alpine flora, i.e., the species with a centre of distribution in the Alps, dies out about the north-centre of Albania, and though there are high mountains to the south these have a flora almost completely distinct from that of the Alps. The Balkan Peninsula was first joined to Europe in the north-west by the formation of the Alpine chains in Miocene times and along the mountains the Central European high mountain flora migrated south-eastwards. The rather sudden cessation of this migration southwards still needs adequate explanation.

In all parts of the world we find problems connected with migration and *in situ* development. Briefly, the centres from which spread occurred may be recognized by the following criteria :

1. The presence of maximum variation. Either the species is here most polymorphic or the genus has most species.
2. The converse, that, in different, but not necessarily all, directions, the polymorphism is found to decrease. In the course of migration certain characters (genes or their allelomorphs) are lost, at least in part through a change in natural selection. It follows that towards the margins of their migrations species are less polymorphic and genera have fewer species than near their centres.
3. Species and genera occupy, as a result of both greater genetical polymorphism and greater plasticity, a wider range of habitats near their centres of origin than near the margins of their distributional areas.
4. Towards the margins of their ranges species may develop characters which are derived from more normal characters—e.g. apomixis, vegetative multiplication, sterility, polyploidy.
5. The known facts of geological and meteorological history may suggest or confirm both centres of origin and lines of migration.

There are, however, many disturbing factors and the determination of migrational lines has, nearly always, to rest on moderate probability for any one species or genus.

Migration, the extension of range in the direction of spread, may or may not be accompanied by retention of area already occupied by the species or other taxonomic group. The converse to migration, retrogression of range, has frequency occurred and may lead to the dying out of species, etc. A considerable number of relict species and genera have ranges now much more restricted than they

formerly had. This explains the discontinuities in the distribution of many of them. A good example are the *Gesneriaceae* of the European flora.

Another important disturbing factor to a regular migrational history is hybridization. This is of much commoner occurrence in plants than in animals and may result in hybrid swarms and allopolyploidy with the formation of new species. Climatic changes and, in recent times, the action of man, increase the chances of migrating species meeting and inter-breeding.

It is impossible to say when or where the Angiosperms arose. The flowering plants now dominate the vegetation of the world but their origin remains a mystery. The latest researches have pushed back the time of their origin to at least the lower Jurassic (Simpson, 1938). As we do not know the place or places of origin of the Angiosperms and they are now so spread over the world and highly differentiated into two hundred or more families it is impossible to be reasonably certain of their first lines of migration. Attention should however, be called to the studies of Guppy (1919). This author in a highly suggestive paper reaches the following conclusions: The great Angiosperm families arose in a period of relatively uniform conditions and became world-ranging. In response to progressive differentiation of environmental (especially climatic) conditions increasing differentiation of families, genera, and species, occurred in that order—great families giving rise to smaller families, families to genera and genera to species. Taking the two main land masses of the earth, the Old World and the New World, Guppy shows that there is decreasing community of distribution between the two areas from cohorts, through families, tribes, and genera, to species. This paper has not received the attention it deserves and many of the suggestions to be derived from it still require investigation.

Wegener's theory of continental drift (Wegener 1924) has attracted considerable attention among biogeographers but its implications have not been fully examined by botanists. The theory is based on two main lines of evidence: 1. geological and geophysical and 2. biogeographical. The evidence on both lines is inconclusive. Recent letters in *The Times* (23.i.39 to 24.ii.39) show something of the basic divergence of views, especially of geophysicists. Reference may also be made to van Waterschoot van der Gracht and others (1928) and Du Toit (1937). On the botanical side, Diels (1928) does not agree that Wegener's theory assists us in understanding plant distribution in the Northern Hemisphere. Kubart (1926) supports, with modifications, the general theory and Sahni (1936) considers, somewhat vaguely, that "we at least seem compelled to agree that drift movements of large magnitude elsewhere have brought into juxtaposition continents once separated by wide oceans. It therefore seems impossible to get away altogether from the idea of continental drift." Lam (1930) also accepts the general terms of the continental drift theory but with special reference to the Malay

Archipelago. Irmscher (1922, 1929) from wider considerations definitely maintains that Wegener's theory is in agreement with the known facts of plant distribution. There is no doubt that the theory of continental drift has certain advantages over the older hypotheses of land bridges but it has been suggested that it raises at least as many biogeographical problems as it solves. There are certainly important problems which it does not solve. It may be suggested that future research on this problem must cover a very wide field if it is to be adequate. At present evidence is too conflicting for a general acceptance of Wegener's views. Not only are both animals and plants involved, but also terrestrial, fresh-water, and marine organisms and both continental and oceanic life. The best position for a phytogeographer is to collect his own evidence and to test any and every possible palaeogeomorphic explanation by this evidence and tentatively to accept the one that appears most helpful.

Phytogeographical divisions of the Earth's Surface.

It will be evident from the facts already discussed that a very close general correlation is found between the distribution of climate and the distribution of plant-life, whether considered as communities of vegetation or as taxonomic units. The high degree of coincidence found between climatic maps and phytogeographic maps is therefore explicable. Nevertheless, the phytogeographer uses plants and not climates as his material, and both his terminology and his criteria are based on vegetation and flora. Unfortunately there are no generally accepted rules for the nomenclature of phytogeographical units. The following scheme has, however, been found to work fairly well in practice :

Realm. A grouping of regions, largely on the distinctness of their floristic history.

Region. The most fundamental phytogeographical division, based on existing major differences between plant communities and floristic composition from region to region.

Division or Province. A portion of a region based particularly on the occurrence of endemics and on statistically different assemblages of species and less on climax vegetational differences.

Further subdivisions can be made almost indefinitely according to the scale of work. It must, however, always be remembered that for any continuous land area boundaries between phytogeographical units are rarely, if ever, sharp. Often there is a wide transitional belt, perhaps even scores of miles across. Sometimes such transitional belts are themselves so important that they are for convenience given equivalence even in names to more extreme units. Often, however, it is sufficient to recognize such transitional areas merely as phytogeographical ecotones.

A considerable number of authors have attempted to classify the land areas of the world on a phytogeographical basis. One of

the best of these attempts is that of Engler (1936), which, with slight modifications, is, in outline, as follows:

I. Northern Extra-tropical Realm.

A. Arctic Region.
B. Subarctic Region.
C. Central European Region.
D. Mediterranean Region (including the Macaronesian Islands).
E. Central Asiatic Region.
F. Eastern Asiatic Temperate Region.
G. Pacific N. American Region.
H. Atlantic N. American Region.

II. Palaeotropic Realm.

A. N. African–Indian Desert Region.
(Probably in part best relegated to the Mediterranean Region in the broad sense.)
B. African Forest and Steppe Region.
C. S.W. Cape Region.
D. S. Atlantic Island Region.
E. Mascarene Region.
F. Southern Indian Region.
G. Monsoon Region.
H. E. Chinese and S. Japanese Region.
I. Sandwich Island Region.

III. Central and S. American Realm.

A. Central American Region.
B. Tropical American Region.
C. Andine Region.
D. Galapagos Region.
E. Juan Fernandez Region.

IV. Austral Realm.

A. Southern S. American Region.
B. Antarctic Region.
C. Kerguelen Region.
D. New Zealand Region.
E. Australian Region.
F. Island Region (Tristan da Cunha, etc.).

V. Oceanic Realm.

Drude (1897) accepts the following as his main phytogeographical divisions:—

Arctic Floral Domain.
Northern Floral Region.
Mediterranean Floral Region.
Central Asiatic Floral Region.

East Asiatic Floral Region.
Indian Floral Region.
Tropical African Floral Region.
Mascarene Floral Region.
South African Floral Region.
Melanesian-New Zealand Floral Region.
Australian Floral Region.
Antarctic Floral Region.
North American Floral Region.
Tropical American Floral Region.
Andine Floral Region.
Antarctic Floral Region.

Martonne (1925) recognizes six main regions or groups of regions, as follows :—

Holarctic Region.
Mediterranean Region.
North Tropical Desert Region of the Old World.
Intertropical Regions.
Austral Temperate Regions.
Antarctic Region.

Schimper (1903) classifies the world's vegetation on a climatic basis but does not give a phytogeographical classification in the usually accepted sense. Various other classifications (e.g., Clarke 1892) have been proposed from time to time. Schimper's statement (1903, author's preface) that " the delimitation of separate floral districts and their grouping into more comprehensive combinations are nearly completed, and the time is not far distant when all species of plants and their geographical distribution will be well known " was premature. It would not be made even to-day by any competent taxonomist with a world outlook.

References.

Allard, H. A. " Length of day in relation to the natural and artificial distribution of plants," in *Ecology*, **13,** 222 (1932).

Brockmann-Jerosch, H. " Baumgrenze und Klimacharakter." Zürich, 1919.

Brockmann-Jerosch, H. " Der Einfluss des Klimacharakters auf die Verbreitung der Pflanzen und Pflanzengesellschaften," in *Engl. Bot. Jahrb.* **49,** Beibl., 109, 19 (1923).

Clarke, C. B. " On biologic regions and tabulation areas," in *Phil. Trans. Roy. Soc. B.* **183,** 371 (1892).

Cooper, W. S. " The broad-sclerophyll vegetation of California." Carnegie Inst. Washington, 1922.

Diels, L. " Kontinentalverschiebung und Pflanzengeographie," in *Ber. Deutsch. Bot. Ges.* **46** (49)–(58) (1928).

Drude, O. " Manuel de Géographie Botanique." Paris, 1897.

Du Toit, A. L. " Our Wandering Continents." London, 1937.

Engler, A. " Syllabus der Pflanzenfamilien," ed. 11, edited by L. Diels (1936).

Fischer, A. und Schwanitz, F. " Die Bedeutung der Polyploidie für die ökologische Anpassung und die Pflanzenzüchtung," in *Züchter*, **8,** 225 (1936).

Flahault, C. " La distribution géographique des végétaux dans la region méditerranéenne française." *Encycl. Biolog.* **18** (1937).

Garner, W. W. " Recent work on photoperiodism," in *Bot. Review*, **3,** 259 (1937).

Good, R. D'O. " A theory of plant geography," in *New Phyt.* **30,** 149 (1931).

Guppy, H. B. " Plant-distribution from the standpoint of an idealist," in *Journ. Linn. Soc.* **44,** 439 (1919).

Hagerup, O. " Über Polyploidie in Beziehung zu Klima, Ökologie und Phylogenie," in *Hereditas*, **16,** 19 (1932).

Hagerup, O. " Studies on polyploid ecotypes in Vaccinium uliginosum L." in *Hereditas*, **18,** 122 (1933).

Hagerup, O. " Studies on the significance of polyploidy " II., in *Hereditas*, **24,** 258 (1938).

Huxley, J. S. " Clines : an auxiliary taxonomic principle," in *Nature*, **142,** 219 (1938).

Irmscher, E. " Pflanzenverbreitung und Entwicklung der Kontinente," I : Hamburg, 1922. II : Hamburg, 1929.

Kubart, B. " Bemerkungen zu Alfred Wegeners Verschiebungstheorie," in *Arb. phytopalaeontol. Laboratoriums Univ. Graz*, **2** (1926).

Lam, H. J. " Het Genet.-Pflantengeogr. Onderzoek van den Indischen Arch. en Wegener's Verschuivingstheorie," in *Tidschr. Koninkl. Nederl. Aardrijksk. Genootsch.* **47,** 4, 553 (1930).

Manton, I. " The problem of Biscutella laevigata L.", in *Zeits. f. indukt. Abstamm.- u. Vererb.* **67,** 41 (1934).

Manton, I. " The problem of Biscutella laevigata " II, in *Ann. Bot. N.S.* **1,** 439 (1937).

Marsden-Jones, E. M. and Turrill, W. B. " Transplant experiments, Summary of results 1928–37," in *Journ. Ecol.* **26,** 380 (1938).

Martonne, E. de. " Traité de Géographie Physique " I. Paris, 1925.

Matthews, J. R. " Geographical relationships of the British Flora," in *Journ. Ecol.* **25,** 1 (1937).

Messer, M. " An agricultural atlas of England and Wales," Ed. 2. London, 1932.

Müntzing, A. " The evolutionary significance of autopolyploidy," in *Hereditas*, **21,** 263 (1936).

Raunkiaer, C. " The Life Forms of Plants and Statistical Plant Geography." Oxford, 1934.

Ridley, H. N. " The Dispersal of Plants throughout the World." Ashford, 1930.

ROHWEDER, H. "Die Bedeutung der Polyploidie für die Anpassung der Angiospermen an die Kalkgebiete Schleswig-Holsteins," in *Beih. Bot. Centrlbl.* **54A,** 507 (1936).

RÜBEL, E. "Pflanzengesellschaften der Erde." Bern-Berlin, 1930.

SAHNI, B. "Wegener's theory of continental drift in the light of palaeobotanical evidence," in *Journ. Ind. Bot. Soc.* **15,** 319 (1936).

SALISBURY, E. J. "The significance of the calcicolous habit," in *Journ. Ecol.* **8,** 202 (1920).

SALISBURY, E. J. "The geographical distribution of plants in relation to climatic factors," in *Geogr. Journ.* **67,** 312 (1926).

SALISBURY, E. J. "The East Anglian Flora," in *Trans. Norfolk and Norwich Nat. Soc.* **13,** 191 (1932).

SCHIMPER, A. F. W. "Plant Geography upon a Physiological Basis." English Translation, Oxford, 1903.

SIMPSON, J. B. "Fossil pollen in Scottish Jurassic rocks," in *Rep. Brit. Assoc.* 1938, 425.

STAPF, O. "The southern element in the British Flora," in *Engl. Bot. Jahrb.* **50,** Suppl. 509 (1914).

STAPF, O. "A cartographic study of the southern element in the British Flora," in *Proc. Linn. Soc.* 129th session, 81 (1917).

TANSLEY, A.G. "A universal classification of plant-communities," in *Journ. Ecol.* **1,** 27 (1913).

TANSLEY, A. G. "The development of vegetation," in *Journ. Ecol.* **4,** 198 (1916).

TISCHLER, G. "Die Bedeutung der Polyploidie für die Verbreitung der Angiospermen," in *Bot. Jahrb.* **67,** 1 (1935).

TISCHLER, G. "Die Bedeutung der Polyploidie für pflanzengeogr. Problem," in *Proc. Zesde Internat. Bot. Congr.* **2,** 54 (1935).

TURRILL, W. B. "Species," in *Journ. Bot.* **63,** 359 (1925).

TURRILL, W. B. "The Plant-Life of the Balkan Peninsula." Oxford, 1929.

TURRILL, W. B. "Climatic factors governing the distribution of plants," in *Gard. Chron.* 3rd Ser. **90,** 313, 331 (1931).

TURRILL, W. B. "Correlation of morphological variation with distribution in some species of *Ajuga*," in *New Phyt.* **33,** 218 (1934).

TURRILL, W. B. "A contribution to the botany of the Athos Peninsula," in *Kew Bulletin,* 1937, 197.

TURRILL, W. B. "The expansion of taxonomy with special reference to the Spermatophyta," in *Biol. Reviews,* **13,** 342 (1938).

TURRILL, W. B. "Ecological Isolation," in *Kew Bulletin,* 1938, 384.

VAN WATERSCHOOT VAN DER GRACHT, W. A. J. M. and OTHERS. "Theory of Continental Drift, A Symposium." London, 1928.

VAVILOV, N. I. "Studies on the origin of cultivated plants." Leningrad, 1926.

WATT, A. S. "On the causes of failure of natural regeneration in British oakwoods," in *Journ. Ecol.* **7,** 173 (1919).

Wegener, A. "The Origin of Continents and Oceans." English Translation, London, 1924.

Willis, J. C. "Age and Area." Cambridge, 1922.

Yapp, R. H. "The concept of habitat," in *Journ. Ecol.* **10,** 1 (1922).

XXVII—TWO NEW FERNS FROM INDIA. K. Biswas.

The genus *Elaphoglossum*, like some other genera of ferns, is in a state of confusion. The remark of Carl Christensen in his Index Filicum, Supplement 3, 103 (1934), that many varieties and subspecies of *Elaphoglossum* from America are good species, is true for India also. Christensen further hints at a mixture of species in *E. conforme* (Sw.) Schott in his "Pteridophyta of Madagascar" (Dansk Bot. Ark. **7,** 165–166: 1932). Similar mixtures and confusion among the Indian species have been discovered by me while examining Indian material of the genus. Comparison of specimens named *E. conforme* from the Eastern Himalaya with the type of *E. conforme* from St. Helena shows that these Indian specimens are quite different from *E. conforme* proper. Beddome's descriptions and illustrations in his Handbook of Ferns of British India and Ceylon and Malay Peninsula, 416, fig. 247 (1883) and Ferns of Southern India, t. 198 (1864) show some of the striking differences in characters from the true *E. conforme*. Wallich in his Catalogue, no. 17 (1829) named this Himalayan specimen of *Elaphoglossum* as *Acrostichum marginatum* Wall. This name was transferred to the genus *Elaphoglossum* by Moore, Ind. Fil. 11 (1857). C. B. Clarke, in his Ferns of Northern India, Trans. Linn. Soc. ser. 2, **1,** 576 (1880), recorded this species as *Acrostichum conforme* Swartz. Under this name Clarke gives the following references and synonymy: Sw. Syn. Fil. **10,** 192, t. 1, fig. 1 (1806); Blume, Fl. Jav. Fil. 23, t. 5 (1828); Fée, 2me. Mém. Foug. 30 (1845); Hook. Sp. Fil. **5,** 198 (1864); Hook. and Bak. Syn. Fil. 401 (1868); Benth. Fl. Austral. **7,** 778 (1878); *A. laurifolium* Thouars sensu Fée, 2me. Mém. Foug. 37, t. 7, fig. 1 (1845); *A. Gayanum* Fée, 2me. Mém. Foug. 37, t. 19, fig. 2; *A. glandulosum* Hook. and Grev. Ic. Fil. t. 3 (1827); *A. marginatum* Wall. Cat. 17 (1829); Fée, 2me. Mém. Foug. 31 (1845); *A. angulatum* Blume, Fl. Jav. Fil. 25, t. 6 (1828); Fée, 2me. Mém. Foug. 52 (1845); *A. gorgoneum* Blume, Fl. Jav. Fil. 28, t. 8 (1828); Fée, 2me. Mém. Foug. 38 (1845); *E. conforme* and *E. laurifolium* sensu Bedd. Ferns of S. Ind. tt. 198, 200 (1864).

The set of Indian specimens identified by the earlier writers as *E. conforme* is composed of three clear-cut species. The wide range of distribution of *E. conforme* noted in Hook. and Bak. Syn. Fil. 401 (1868) is suggestive of such a mixture of species in this *conforme* group of Indian *Elaphoglossum*. The true *E. conforme* is not an Indian species at all. Christ's record of *E. conforme* from North India in his Monographie des Genus Elaphoglossum, 43 (1899) is

evidently given on Beddome's authority, and refers actually to *E. marginatum* (Wall. ex Fée) Moore (*Acrostichum marginatum* Wall.). Two new species distinguished in this *conforme* group of Indian Elaphoglossums are *E. Ballardianum* Biswas and *E. Krajinae* Biswas. All the three species come under Ordo *Stenoneura*, Sectio *Craspedoglossa* and can be grouped under Divisio *Conformia*, according to Christ's classification of the genus.

The species described by Beddome in Handb. Ferns Brit. Ind. 416 (1883) under the name *E. latifolium* has been rightly separated by Christ in his Mon. des Genus Elaphoglossum, 33 (1899) as *E. laurifolium* (Thouars) Moore. *E. latifolium* is a tropical American species and has not yet been recorded from India. Christensen in his Index Filicum, 304 (1905) accepted Christ's views. My examination of herbarium specimens at Kew, British Museum (Natural History) and Calcutta leads me to the same conclusion. The Indian specimens of *E. squarrosum* (=*E. hirtum* (Sw.) C. Chr.) have also been found to be a mixture of two distinct species. These are at present being described by Dr. Vladimir Krajina as two new South Indian species.

I am indebted to Dr. V. Krajina, Mr. F. Ballard and Dr. T. A. Sprague for their helpful suggestions.

Elaphoglossum marginatum (*Wall. ex Fée*) *Moore*, Ind. Fil. **2,** 11 (1857). *Acrostichum marginatum* Wall. Cat. 17 (1828) nomen ; Fée, 2me. Mém. Foug. 31 (1845) partim ; 5me. Mém. Foug. 43 (1853). *Acrostichum conforme* Sw. ; Hook. & Bak. Syn. Fil. 401 (1868), partim ; C. B. Clarke, Trans. Linn. Soc. Bot. ser. 2, **1,** 576 (1880). *Elaphoglossum conforme* (Sw.) Schott ; Bedd. Ferns S. Ind. t. 198 (1864) ; Handb. Ferns Br. Ind. 416, pl. 247 (1883), partim ; H. Christ, Monogr. Elaphoglossum, 43 (1899) ; C. Christensen, Ind. Fil. 305 (1906), Suppl. 3, 103 (1934).

Rhizomata breviter repentia, squamosa. *Squamae* ovato-lanceolatae usque lanceolatae, acutae vel acute acuminatae, interdum minute irregulariter dentatae, 5 mm. longae, basi 2 mm. latae. *Stipites* ± caespitosi, frondium sterilium 3–7·5 cm. longi, frondium fertilium usque 15 cm. longi. *Laminae* lanceolatae usque linearioblongae, basi et apice aeque sensim attenuatae, acutae vel acuminatae, usque 31 cm. longae et 5·2 cm. latae, coriaceae, margine cartilagineo.

Rhizome short, densely scaly ; scales dark brown, ovate-lanceolate to lanceolate, acute or acutely acuminate, sometimes minutely irregularly dentate, not hair-pointed, cells elongate with thicker and darker walls than in *E. conforme*, 5 mm. long, 2 mm. broad at base. *Stipes* more or less tufted, reddish-brown, densely scaly at point of attachment to rhizome, sometimes sparsely deciduously scaly above, in sterile fronds 3–7·5 cm. long, in fertile fronds up to 15 cm. long. *Blades* lanceolate to linear-oblong, gradually attenuated at both ends, acute, sometimes acuminate, up to 31 cm. long, 5·2 cm. broad, fertile smaller than sterile, coriaceous ; margin

entire, slightly revolute, with a cartilaginous band all round; veins indistinct, 1-forked, attaining the cartilaginous margin. *Sori* dense, uniformly spreading over the entire under-surface on both sides of the smooth reddish-brown or yellowish-brown midrib.

Distribution. Himalayas from Nepal to Sikkim and the Khasia and the Naga Hills in Assam, between 1220 m. and 2225 m.

Wall. Cat. no. 17, Nepal, Sheopore, 1821, *Wallich* (type in Herb. Kew.); Sikkim, 2100 m., Sept. 1882, *Levinge*; Sikkim, 180 m., Oct. 1881, *Gamble* 9884; Sikkim, Jeylap Road, 180 m., Nov. 1880, *Gamble* 9938; Suru Susu, June 26, 1885, Khasia, 1200–1800 m., *Hook. & Thoms.*; Kalapauee, Khasia, 1650 m., and Khasia, Oct. 28, 1850, *Hook. & Thoms.*; Vale of Rocks, 1500 m., Khasia, Sept. 1886, *Clarke* 45828 C; Shora Reef, 1680 m., Khasia, Oct. 16, 1872, *Clarke* 19239 E; Lohra, Khasia, 1350 m., Oct. 15, 1872, *Clarke* 18826 A; Kohima, 1800 m., Oct. 21, 1885, *Clarke* 40971; Logra Reef, Khasia, 1500 m., Nov. 28, 1871, *Clarke* 14778; Road from Tonglu to Darjeeling, 2100 m., Oct. 1871, Darjeeling, *Levinge*; Sikkim Himalaya, Ching Tong, 1500 m., *Gammie* 293/267; Darjeeling, 2280 m., Oct. 10, 1877, *Clarke* 26913 A; Sikkim, *Dr. Jerdon*; Sikkim Himalaya, prestd. *Dr. Treutler*, May 1875; Chura, Mamloo, on trees, June 1850; Assam, 1870–1880, *G. Mann*; Herb. *Griffith*, Birmah? (The locality quoted on the label, "Birmah," is doubted. I have not so far observed any specimen of this species recorded from Burma, although it is possible that the species may extend from the upper hill ranges of Assam to Upper Burma.)

The species differs from others by the structure of its rhizome, the scales, and the characteristic fronds with the cartilaginous band along the margin. *Elaphoglossum conforme*, as the type from St. Helena shows, has a wide creeping rhizome densely matted with soft, rather fragile, pale brown scales; stipes much shorter, developing vertically, almost at right-angles, from the horizontally spreading rhizome; lamina much smaller, up to only 10·5 cm. long and 2·7 cm. broad, apex obtuse, and margin not provided with cartilaginous band; veins slightly wide (about 2 mm. apart). *Elaphoglossum marginatum* is confined to the Eastern Himalayas, growing abundantly in the Khasia Hills from 1000 to 2000 m.

Elaphoglossum Ballardianum *Biswas*, sp. nov.

Rhizomata repentia, squamosa, usque 5 mm. crassa. *Squamae* ovatae usque ovato-lanceolatae, cordatae, acutae, integrae vel interdum±irregulariter dentatae vel raro minute fimbriatae, basi pallide brunneae, apicem versus atro-brunneae. *Stipites* frondium sterilium 3·5–15 cm. longi, frondium fertilium 5–20 cm. longi. *Laminae* anguste ellipticae usque lineari-ellipticae, basi et apice sensim attenuatae, acute acuminatae, usque 20 cm. longae et 3 cm. latae, coriaceae, subtus squamulis punctiformibus nigrescentibus interdum fimbriatis sparsis conspersae, margine haud cartilagineo interdum leviter revoluto; frondes fertiles nonnunquam sterilibus angustiores. *Venae* obscurae.

Rhizome creeping, scaly, up to about 5 mm. thick, furnished with wiry roots ; scales ovate to ovate-lanceolate, cordate, acute, often acuminate, pale brown at the base becoming dark to blackish brown towards the apex, puckered or almost bullate when dry, entire or sometimes more or less irregularly toothed or rarely minutely fimbriate, cells densely packed, less elongate towards the apices than those of the above species. *Stipes* from a horizontally creeping rhizome, suberect, naked or with pale brown deciduous scales reaching the base of the lamina or extending to the lower portion of the midrib, 3·5–15 cm. long, in fertile leaves 5–20 cm. long. Blades narrowly elliptic to linear-elliptic, gradually attenuated at both ends, acutely acuminate, up to 20 cm. long, 3 cm. broad, fertile sometimes narrower than sterile, lower surface dotted with punctiform blackish scales which are sometimes fimbriate, margin not cartilaginous, entire, sometimes slightly revolute, texture coriaceous, rather thinner than in the other two species here described ; veins faintly visible.

Distribution. Common in the Nilgiri mountains in South India ; ascending up to an elevation of 2438 m.

Nilgiris, 2100 m., *Beddome* (type in Herb. Kew.) ; Nilgiris, 2100 m., *Gamble* 21420 ; Nilgiris, Otty., 2100 m., Aug. 1885, *Gamble* 16661 ; Kudrabad, Sispara Road, 2400 m., Nilgiris District, *Gamble* 13473 ; Kudrabad, Sispara Road, 2400 m., 1883, Nilgiris District, *Gamble* 13474 ; Nilgiris, *Beddome* 5 ; Ootacamund, 12/69, *Babcock.*

This new species is quite distinct from *Elaphoglossum conforme*—in the structure of the scales of the rhizome, and the much longer, acute or acuminate lamina, gradually attenuated at both ends. Beddome's figures (F.S.I. pl. 198) are not accurate representations of the specimen drawn.

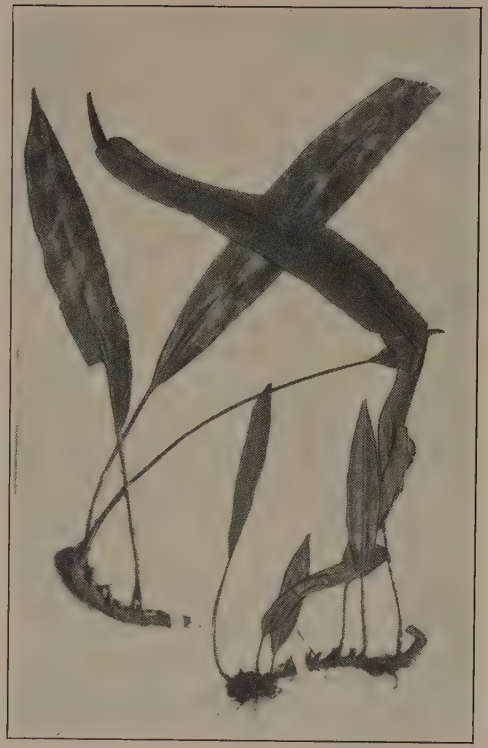
Elaphoglossum Krajinae *Biswas*, sp. nov.

Rhizomata late repentia, brunnea, apice squamis dense vestita, usque 1 cm. crassa. *Squamae* ovato-lanceolatae, basi rotundatae, acute acuminatae, integrae vel±irregulariter lobulatae vel raro remote ciliatae, usque 8 mm. longae, basi 3 mm. latae, molles, fragiles, pallide brunneae. *Stipites* suberecti, nudi vel squamosi, frondium sterilium usque 22 cm. longi, frondium fertilium usque 26 cm. longi, rubido-brunnei. *Laminae* lanceolatae vel anguste ellipticae usque lineari-oblongae, basi cuneatae vel raro sub-rotundatae, frondium fertilium raro basin versus sensim attenuatae, acutae vel obtusae, integrae, margine crassiusculo saepe revoluto, usque 28 cm. longae et 4 cm. latae, coriaceae. *Venae* indistinctae.

Rhizome wide-creeping, scaly, densely covered with scales at the apex, brown, up to 1 cm. diam . ; scales pale brown, rather soft but fragile when dry, ovate-lanceolate, rounded at the base, acutely acuminate, entire or sometimes more or less irregularly lobulate or rarely remotely ciliate, up to 8 mm. long, 3 mm. broad at base, cells of nearly uniform dimensions, not elongated. *Stipes* suberect,

[*Kew Bulletin*, 1934]

1. *Elaphoglossum Ballardianum* Biswas.
Type sheet collected by Beddome in the Nilgiris, 2100 m.



2. *Elaphoglossum Krajinae* Biswas.
Type sheet collected by Thwaites (C.P. 1311) in Central Province, Ceylon.

[*To face page* 240.

naked or squamose, reddish-brown, in sterile leaves up to 22 cm. long, in fertile leaves up to 26 cm. long. *Blades* lanceolate or narrowly elliptic to linear-oblong, cuneate or rarely somewhat rounded at the base, rarely gradually attenuated towards the base in fertile fronds, acute or obtuse, entire, margin rather thick, often revolute, up to 28 cm. long, 4 cm. broad, glabrous on both sides, coriaceous, veins indistinct.

Distribution. In the Nilgiris and Pulney Hills of South India and high hills of Ceylon, ascending up to 2438 m.

Most elevated parts of Cent. Province, Ceylon, *Thwaites* C.P.1311 (type in Herb. Kew.); Pediotalagalla 2100–2400 m., Ceylon, 8/67, *Thwaites* C.P.1311 (type number in Herb. Calcutta); Ceylon, *Mrs. Carr*; Bear Shola, Kodaikanal, Pulneys, May 19, 1898, *Bourne* 4972; Kodaikanal Waterfall, Pulneys, May 30, 1898, *Bourne* 4973; Ceylon, *Gardner* 1310, 1165; Nuwara Eeya, Ceylon, May 1906, *Matthew* 635; Adam's Peak, 2100 m., on trees, Feb. 14, 1908, *Matthew*.

This species differs from *Elaphoglossum conforme* and the other two species, in its characteristic rhizome, the scales, and longer, broader, thick-coriaceous, obovate-lanceolate, acute or obtuse lamina. The species is confined to the hills of South India and Ceylon. Thwaites no. 1311, quoted by Christ in his monograph (*loc. cit.* p. 36) under *Elaphoglossum laurifolium* is the type number of this new species. Christ evidently accepted, on Beddome's authority, all the sheets of *Elaphoglossum latifolium* of Beddome as *Elaphoglossum laurifolium* without, perhaps, actual reference to the sheets. Such an examination of Indian specimens of the set of *Elaphoglossum latifolium* as identified by Beddome might have prompted Christ to separate this species from the true *Elaphoglossum laurifolium*. *Elaphoglossum laurifolium* (*Acrostichum commutatum* Mett.) is confined to the higher hills of Ceylon and South India. The following specimens at Kew, British Museum (Natural History) and Edinburgh represent authentic *Elaphoglossum laurifolium* (Bedd.) Christ. Bolumpatly Hills, 1500 m., *Beddome*; Ceylon, *Thwaites* C.P. 1310. (as recorded correctly by Christ); Ceylon, *Robinson* 20; Nilgiri Hills, 1200 m., Nov. 1870, *Henderson*; Noolan-Kanda Peak, Matali, Ceylon, Jan. 1860, C. P. 1310.

XXVIII—TROPICAL AFRICAN PLANTS: XVII*.

J. Hutchinson.

Commelinaceae.

Floscopa myosotoides *Hutch.* in Hutch. & Dalz. Fl. West Trop. Afr. **2**, 311 (1936); affinis *F. flavidae* C. B. Cl., sed caulibus ad apices foliatis, inflorescentiis parce pubescentibus differt.

Caules e basi prostrati et e nodis inferioribus radicantes, ad apicem foliati, glabri. *Folia* anguste triangulari-lanceolata, acuta, basi leviter rotundata, 3–4 cm. longa, 0·5–1 cm. lata, glabra;

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*Continued from K.B. 1937, 341.

vagina 4 mm. longa, glabra. *Inflorescentia* terminalis, pauciflora, leviter ramosa, pilis brevibus apice glandulosis parce pubescentia ; bracteae parvae, mox deciduae ; pedicelli 2 mm. longi, basi articulati. *Sepala* obovato-elliptica, 1·5–2 mm. longa, glabra. *Petala* coerulea, elliptica, tenuia, 1·5 mm. longa. *Stamina* 6, antheris didymis subglobosis. *Ovarium bilobum*, glabrum ; stylus 0·75 mm. longus. *Capsula* obovoideo-globosa, 2 mm. longa, nitida. *Semina* violacea, 1 mm. diametro, multicostata, embryostega orbiculari apice albo-punctiformi.

Senegal : Casamance, Feb., *Chevalier* 2582. French Guinea : Konkouré, Oct., *Caille*. Fouta Jallon, *Chevalier* 18660. Sierra Leone : Mabould, Oct., *N. W. Thomas* 3614 (type in Kew Herb.). Yonibana, Oct., *N. W. Thomas* 4134. Mamaba, *N. W. Thomas* 4552. Malema, Nov., *Deighton* 334. Njala, Oct., *Deighton* 1338. Materboi, Oct., *Glanville* 18. Masactaba, weed in rice fields, *Glanville* 50. Liberia : Monrovia, Nov., wet sandy soil in thickets, *Linder* 1412.

Floscopa Lelyi *Hutch.* op. cit. 311 ; affinis *F. axillari* C. B. Cl., sed inflorescentiis glomerato-ramosis, ramis brevibus, caulibus et foliorum vaginis purpurascentibus differt.

Herba 0·3-0·75 m. lata, semi-erecta ; internodia 2·5–4 cm. longa, glabra, purpurascentia. *Folia* lineari-lanceolata, subacuta, e basi ad apicem sensim angustata, 5–6 cm. longa, 6–7 mm. lata, glabra, supra viridia vel purpurascentia, nervis utrinsecus 4–5 prominulis ; vagina clausa, 1 cm. longa, in sinu leviter piloso-ciliata. *Inflorescentia* glomerato-ramosa, 3–4 cm. longa, ubique breviter pubescentia ; bracteae oblanceolatae, parvae ; pedicelli 1·5 mm. longi. *Sepala* elliptico-obovata, 3·25 mm. longa, leviter pubescentia. *Petala* purpurea, mox decidua, obovata, venosa, sepalis vix aequilonga. *Antherarum loculi* discreti. *Fructus* breviter stipitatus, transverse oblongo-ellipsoideus, 2·25 mm. longus, apiculatus. *Semina* ambitu depresso-globosa, obtuse costata, atro-violacea, minute punctata, embryostega verruculosa albida.

Nigeria. Naraguta, in stony stream beds, Nov., *Lely* 704 (type in Kew Herb.).

Cyanotis bulbifera *Hutch.* op. cit. 315, 316, fig. 287 ; affinis *C. angustae* C. B. Cl., sed bractea capitulis subtendente multo breviori, bulbi squamis dense adpresse villosis differt.

Caulis basi bulbiformus, basibus persistentibus foliorum dense villosis indutus. *Folia* late linearia, acuta, 15–20 cm. longa, 6–8 mm. lata, utrinque glabra sed marginibus laxe ciliata. *Inflorescentiae* paucae, subumbellatae, longe pedunculatae ; bractea subtendens lanceolata, 2–3 cm. longa, ciliata ; pedunculi secondarii inaequales, usque ad 5·5 cm. longi, laxe pubescentes. *Capitula* obliqua, circiter 1 cm. longa, bractea subtendenti lanceolata 1·5 cm. longa leviter recurvata breviter ciliata ; bracteae flores subtendentes oblique lanceolatae, usque ad 1 cm. longae, pilosae et ciliatae. *Sepala* alba, lanceolata, 3·5 mm. longa, longe pilosa. *Petala* rosea

vel coerulea, alte connata, 7 mm. longa, partibus liberis ovatis striatis. *Filamenta* filiformia, spiraliter torta, apicem versus longe villosa ; antherae 1·5 mm. longae. *Ovarium* longe pilosum. *Stylus* undulatus, tenuiter pilosus. *Capsula* pubescens, 3–4 mm. longa ; semina laevia.

French Sudan : Sikasso, in arid ground, Apr., *Chevalier* 747 (type in Kew Herb.). Couroula, Apr., *Chevalier* 730. Ivory Coast : Valley of the Middle Sassandra, at Orodougou, June, *Chevalier* 21813 bis. Nigeria : Sokoto Province, abundant, *Dalziel* 543.

Cyanotis scaberula *Hutch.* op. cit. 315, 316 ; affinis *C. rubescenti* A. Chev. sed herba erecta haud purpurascens, bracteis minute scaberulis differt.

Herba erecta radicibus numerosis, circiter 10 cm. alta ; caules 3–5, glabri. *Folia* pauca, basalia linearia, acuta, 7–9 cm. longa, 1·5 mm. lata, sicco minute scaberula ; folia superiora multo minora, lineari-lanceolata ; vagina clausa, 7 mm. longa, extra crebre nervosa et minute scaberula. *Capitula* pedunculata, 6 mm. longa, bractea subtendenti ovato-lanceolata et duplo longiori ; bracteae florales oblique ovatae, acutae, margine hyalinae. *Sepala* oblonga, 5 mm. longa, mucronata. *Petala* in medio tertio conniventia, 7 mm. longa. *Filamenta* filiformia, apicem versus longe et intricate pilosa ; antherae 1·25 mm. longae. *Ovarium* apice pilosum ; stylus filiformis. *Fructus* non visus.

French Guinea : Kouroussa, May, *Pobéguin* 258 (type in Kew Herb.) ; 368.

Cyanotis Deightonii *Hutch.* op. cit. 315, 317 ; affinis *C. lanatae* Benth. sed indumento foliorum et bractearum haud lanato differt.

Herba 1 m. alta ; caules simplices, internodiis circiter 9 cm. longis molliter pubescentibus sed haud lanatis. *Folia* late linearia, mucronata, 6–10 cm. longa, 6 mm. lata, breviter pubescentia ; vaginae 2 cm. longae, molliter pubescentes. *Capitula* sessilia, multiflora, oblique ovoidea, 2–3 cm. diametro ; bracteae numerosissimae, oblique oblongo-lanceolatae, acutae, usque 6 mm. longae et 2·5 mm. latae, 3-nervae, longe ciliatae et extra parce pilosae. *Sepala* cymbiformi-lanceolata, apice cucullata, 4·5 mm. longa, carina pilosa. *Petala* connata, 5 mm. longa. *Filamenta* longe villosa. *Ovarium* apice pilosum. *Capsula* triquetra, pilosa. *Semina* verrucosa, embryostega punctiformi.

Sierra Leone : Freetown, herb in grassy places, flowers pale blue, Oct., *Deighton* 43 (type in Kew Herb.).

Commelina Thomasii *Hutch.* op. cit. 317 ; affinis *C. macrospathae* Gilg et Lederm. ex Mildbr., sed seminibus laevibus laevibus et spathis minoribus differt.

Caules debiles, internodiis glabris. *Folia* late lineari-lanceolata, sensim et acute acuminata, ad vaginam breviter angustata, 6–13 cm. longa, circiter 1·5 cm. lata, utrinque breviter sparse pubescentia,

nervis parallelis utrinsecus circiter 4 prominulis; vaginae 2 cm. longae, tenuiter pilosae, apice obliquae et longe ciliato-pilosae. *Spatha* terminalis, solitaria, pedunculata, ovata et longe rostrato-acuminata, 5 cm. longa, 2 cm. lata, utrinque parce pubescentia, marginibus liberis minute ciliolatis; pedunculus 2–2·5 cm. longus, pubescens. *Inflorescentia* 3-flora, leviter exserta; pedicelli 6 mm. longi, demum recurvati. *Sepala* obovata, 4 mm. longa. *Petala* 6 mm. longa. *Capsula* ellipsoidea, rostrata, 6 mm. longa, glabra. *Semina* oblongo-ellipsoidea, 2·5 mm. longa, laevia, leviter carinata.

Sierra Leone: Yonibana, Nov., *N. W. Thomas* 5205 (type in Kew Herb.).

Polyspatha glaucescens *Hutch.* op. cit. 320; affinis *P. paniculatae* Benth., sed foliis angustioribus, inflorescentiis plerumque solitariis et foliis minoribus, bracteis haud longe ciliatis differt.

Herba decumbens; caules e nodis inferioribus radicantes, leviter pubescentes, internodis interdum elongatis. *Folia* elliptica vel elliptico-obovata, sensim acuminata, basi acuta, 5–9 cm. longa, 2·5–4 cm. lata, glabra, nervis parallelis utrinsecus circiter 3 sicco prominulis, nervis transversis vix manifestis; vaginae 1–1·3 cm. longae, apice oblique truncatae et parce ciliatae. *Inflorescentia* plerumque solitaria, 5–6 cm. longa; axis flexuosus, breviter pubescens, basin versus bractea foliacea oblongo-lanceolata 2 cm. longa instructus; bracteae 2-florae, reflexae, late ovatae, subacutae, 1 cm. longae et latae, circiter 7-nervae, breviter ciliatae. *Sepala* elliptica, 6 mm. longa, 1-nerva, glabra. *Petala* et stamina non visa. *Ovarium* glabrum. *Fructus* non visus.

Ivory Coast: Morénou, Dec., *Chevalier* 22470. Cameroons Mt.: 950 m., Dec., *Mann* 2138 (type in Kew Herb.). Fernando Po: 600 m., *Mann*.

Liliaceae.

Scilla picta *A. Chev.* Explor. Bot. Afr. Occid. Franç. 657, nomen (1920); Hutch. op. cit. 350; affinis *S. cameroonianae* Baker, sed pedicellis brevioribus, racemis foliis longioribus, foliis angustioribus differt.

Bulbi anguste vel late ovoidei, usque ad 3 cm. longi, squamis membranaceis nitidis induti. *Folia* 3–5, maculata, lineari-lanceolata, utrinque attenuata, usque ad 15 cm. longa et 1 cm. lata, 8–10-nervia, glabra, tenuia. *Racemi* foliis longiores, graciles; bracteae parvae, glabrae; pedicelli usque ad 5 mm. longi. *Perianthii segmenta* 4 mm. longa, oblongo-elliptica, margine anguste membranacea. *Filamenta* 2 mm. longa; antherae 0·75 mm. longae. *Ovarium* glabrum. *S. mankonensis* et *S. sudanica A. Chev.* op. cit. 657, nomina.

French Sudan: Gourma; between Diapaga and Fada, July, *Chevalier* 24416 (type in Paris Herb.); between Fada and Koupela, July, *Chevalier* 24513; Karankasso, May, *Chevalier* 902; Mossi, Aug., *Chevalier* 24624. French Guinea: Faranna, May, *Chevalier* 13413; Kankan-Kouroussa, *Brossart* in *Herb. Chevalier* 15719.

Ivory Coast : Mankono country, June, *Chevalier* 21855 ; 21871 bis. Dahomey : Savalou Circle, between Banté and Pira, May, *Chevalier* 23742.

Drimia incerta *A. Chev.* Explor. Bot. Afr. Occid. Franç. 653, nomen (1920) ; Hutch. op. cit. 351 ; species foliis linearibus piloso-ciliatis, bracteis parvis mox deciduis distincta.

Bulbus ovoideus, circiter 6 cm. longus, 3 cm. diametro. *Folia* immature tantum visa, linearia, piloso-ciliata, basibus persistentibus et purpurascentibus. *Racemi* graciles, circiter 40 cm. longi, in parte tertia superiore floriferi ; flores pauci (12–15), ascendentes vel patuli ; pedicelli 3 mm. longi ; bracteae mox caducae, e basi lato lineares, 5 mm. longae. *Perianthium* 1·4 cm. longum, segmentis dimidio inferiore connatis mox recurvatis vel fere reflexis demum spiraliter contortis. *Stamina* segmentis subaequilonga. *Capsula* ambitu elliptico-orbicularis, circiter 8 mm. longa et 7 mm. lata. *Semina* nigra, compressa.

Ivory Coast : Upper Sassandra, near Gouékouma, about 750 m., May 1909, *Chevalier* 21656 bis. Dourou Mountain, 900 m., near Kouale, May 1909, *Fleury in Herb. Chevalier* 21733 (type in Paris Herb.).

Asparagus Warneckei *Hutch.* op. cit. 351, 352 ; affinis *A. racemoso* Willd., sed pedicellis basin versus articulatis, cladodiis longioribus differt.

Scandens ; rami flexuosi, satis robusti, angulati, spinis recurvatis 7 mm. longis acutissimis armati. *Cladodia* plerumque fasciculata, acinaciformia, acuta, 3–4 cm. longa, 2–2·5 mm. lata, uninervia, glabra. *Inflorescentiae* racemosae, plerumque fasciculatae vel interdum solitariae, basi spina brevi armatae, usque ad 5 cm. longae ; bracteae ovato-triangulares, acutae, 3·5 mm. longae, glabrae ; pedicelli 5–6 mm. longi, basin versus articulati. *Flores* cremei, odorati. *Perianthii segmenta* anguste obovata, 4 mm. longa. *Filamenta* 2·5 mm. longa ; antherae 0·75 mm. longa. *Ovarium* breviter et crasse stipitatum, glabrum, stylis erectis ad medium connatis. *Fructus* non visus. *A. drepanophyllus* var. *Warneckei* Engl. ex Hutch. op. cit. 352, nomen.

French Guinea : Pita, Nov., *Pobéguin*. Gold Coast : Accra Dodowah Plains, Feb., *Irvine* 1502. Togo : near Lome, *Warnecke* 28 (type in Kew Herb.).

Araceae.

Amorphophallus gracilior *Hutch.* op. cit. 361, 362 ; affinis *A. consimili* Blume, sed spatha et spadice breviori, pedunculo longo differt. *A. gracilis* A. Chev. Explor. Bot. Afr. Occid. Franç. 680, nomen, non Engl.

Tuber depressus, 3–3·5 cm. diametro, apice vaginis membranaceis instructus. *Folia* non visa. *Scapus* 15–20 cm. altus ; pedunculus gracilis, circiter 3 mm. crassus, glaber. *Spatha* late lanceolata, sensim acute acuminata, 4–5·5 cm. longa, marginibus inferne

convolutis, utrinque glabra, extra tenuiter striato-nervosa. *Spadix* spatha fere duplo longior, intra spatham sessilis, parte feminea 5 mm. longa, mascula 1·3 cm. longa, appendice 4–5 cm. longa gracili superne leviter ampliata. *Stamina* poris duobus dehiscentia. *Ovaria* globosa, stigmatibus obovoideis.

DAHOMEY: Zagnanado Circle, Hollis Country, between Adjaouéré and Abbo, Feb. 1910, *Chevalier* 22957 (type in Paris Herb.).

Anubias gracilis *A. Chev.* Explor. Bot. Afr. Occid. Franç. 683, nomen (1920); Hutch. op. cit. 365, 366; species foliis leviter hastato-trilobatis lobis ovato-oblongis distincta.

Petioli 20–25 cm. longi, graciles, angulati. *Folia* leviter hastato-trilobata, ambitu triangularia, circiter 12 cm. longa et 10 cm. lata, glabra, lobis ovato-oblongis apice rotundatis, nervis lateralibus numerosis prominentibus intra marginem conjunctis, venulis transversis obscuris. *Pedunculi* graciles, 12–14 cm. longi, glabri. *Spathae* late ellipticae, mucronatae, 2·5 cm. longae, fere 1·5 cm. latae, obscure nervosae. *Spadix* spatha aequilongus, parte superiore $\frac{3}{4}$ floribus masculis dense aggregatis indutus, inferne floribus femineis circiter 30. *Ovarium* late ovoideum, stylo brevi, stigmate discoideo parvo.

FRENCH GUINEA: Konianke's country; Fassakoidou, Feb. 1909, *Chevalier* 20800 (type in Paris Herb.).

Anubias gigantea *A. Chev.* Explor. Bot. Afr. Occid. Franç. 683, nomen (1920); Hutch. op. cit. 365, 366; affinis *A. gracili* A. Chev. ex Hutch., sed foliis profunde trilobatis, pedunculis longioribus, spatha multo longiori differt. *A. gigantea* var. *tripartita* A. Chev. op. cit.

Petioli crassi, sicco angulati, apice pro 2 cm. tumidi. *Folia* profunde hastato-trilobata, lobo medio ovato-triangulari apice rotundato obtuso circiter 15 cm. longo et 10 cm. lato, lobis lateralibus oblongo-lanceolatis obtusis 15–16 cm. longis usque ad 6 cm. latis, nervis lateralibus arcuatis numerosis. *Pedunculi* robusti, circiter 6 mm. crassi, circiter 25 cm. longi. *Spathae* valde convolutae, abrupte apiculatae, 7–8 cm. longae. *Spadix* spatha leviter longior, parte superiore $\frac{5}{6}$ floribus indutus, inferne floribus femineis dense aggregatis.

FRENCH GUINEA: Nionsomoridou, near Beyla, 600–700 m., Feb. 1909, *Chevalier* 20857 (type in Paris Herb.); between Dieudedou and Nionsomoridou, 600–700 m., Feb. 1909, *Chevalier* 20858. IVORY COAST: Upper Sassandra; Toura country, between Farafina and Ouodé, May 1909, *Chevalier* 21634; between Sanrou and Ouodé, May 1909, *Chevalier* 21606.

IRIDACEAE.

Aristea djalonis *Hutch.* op. cit. 375, 376. *Anthericum djalonis* A. Chev. Explor. Bot. Afr. Occid. Franç. 648, nomen (1920); inter species africanas occidentales inflorescentia plerumque ramosa axi fere alato distincta.

Rhizoma breve, radicibus gracilibus numerosis; caulis usque ad 50 cm. altus, laxe foliatus. *Folia* radicalia linearia, usque ad 20 cm. longa, 5 mm. lata, crebre nervosa, glabra, marginibus tenuibus brunneo-sclerosis. *Flores* non visi. *Infructescentia* simplex vel parce ramosa; axis complanatus, fere alatus; bracteae inferiores oblongo-lanceolatae, circiter 2 cm. longae. *Fructus* glomerati, sessiles, oblongo-ellipsoidei, mucronati, nigrescentes, fere 1 cm. longi, seminarum impressionibus undulati et obscure reticulati. *Semina* leviter verrucosa.

French Guinea: Dalaba-Diaguisa Plateau, Fouta-Jallon, 1000 m., fr. Sept.–Oct., 1907, *Chevalier* 18859 (type in Paris Herb.). Diaguissa, 1300–1400 m., fr. Apr. 1905, *Chevalier* 12652.

Agavaceae.

Dracaena scoparia *A. Chev.* Explor. Bot. Afr. Occid. Franç. 647, nomen (1920); *Hutch.* op. cit. 383, 384; affinis *D. Mannii* Baker, sed frutex, inflorescentia gracillima, pedicellis fructiferis multo longioribus differt.

Frutex 2 m. altus; rami ultimi glabri, circiter 6 mm. diametro. *Folia* conferta, lineari-oblanceolata, acute mucronata, basi semi-amplexicaulia, usque ad 35 cm. longa, 3–5 cm. lata, nervis parallelis utrinque circiter 15 prominulis; costa infra valde prominens. *Inflorescentia* paniculata, gracillima, 30–35 cm. longa, ramis gracilibus patulis usque ad 15 cm. longis; bracteae inferiores ovato-oblongae, apiculatae, 1 cm. longae, extra distincte nervosae; pedicelli 5 mm. longi, demum (fructu) rigidi et 1·5 cm. longi, supra medium articulati. *Perianthium* alabastro tantum visum, 6 mm. longum. *Fructus* subglobosus et 1·5 cm. diametro vel didymus et 2·5 cm. latus, laevis.

Ivory Coast: Erymacougnié, fl. Jan. 1907, *Chevalier* 16967 (type in Paris Herb.); Alepe, Attie Prov., fr. Feb. 1907, *Chevalier* 17484.

XXIX—NEW OR LITTLE-KNOWN PLANTS FROM SOUTHERN INDIA: X.* C. E. C. Fischer.

N.B.—The regions noted in brackets after the name of the species are those from which it has been previously reported.

Tetracera scandens (*Linn.*) *Merr.* [Dilleniaceae].
(Assam to Singapore and Ceylon.)

Tinnevelli District: Tirukurungadi Hills, fls. May, *P. V. Mayuranathan* (in Herb. Madras Mus.) without number.

Begonia Aliciae *C. E. C. Fischer*, sp. nov. [Begoniaceae].

B. crenatae Dryand. peraffinis, sed foliis acuminatis haud cordatis, nervis basalibus paucioribus, perianthii ♀ segmentis 6, capsularum alis sub ovario decurrentibus acutis cohaerentibus differt.

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*Continued from K.B. 1938, 126.

A scapigerous *herb*, rhizome short, apparently fleshy, with numerous fibrous rootlets. *Leaves* ovate to rotund-ovate, acute or acuminate, base rounded or nearly truncate, 5–13 cm. long, 3·2–8·5 cm. wide, basal nerves 5, the two next the midrib nearly vertical for a short distance and then bending outwards, 2 lateral pairs ascending from the midrib above the middle, all the nerves forking and running to the lobulate, apiculately crenate margins, upper surface furnished with scattered short, stout hairs, glabrous below ; petioles 2·5–6 cm. long. *Scape* 10–30 cm. long, sometimes bearing a simple leaf similar to the radical, but much smaller, below the middle, with narrowly ensiform, acuminate stipules up to 5 mm. long ; bracts at the forks ovate, acute, 3–5 mm. long ; bracteoles similar, smaller. *Flowers* pink, monoecious, the ♂ above the ♀ ; pedicels up to 2·6 cm. long. ♂ *perianth-segments* 4, subequal, broadly elliptic or elliptic-obovate, obtuse, 1 cm. long, 5·5 mm. wide. *Stamens* monadelphous, column 1·4 mm. long, free part of filaments up to 1 mm. long ; anthers about 16, oblanceolate, 1·2 mm. long. ♀ *perianth-segments* 6, oblong, obtuse or sometimes the inner acute, 9·3 mm. long, 4·6 mm. wide, the innermost usually considerably smaller and narrower. *Styles* 3, 2·6 mm. long, rather stout ; stigmas broad, curved into a half circle. *Ovary* subglobose, somewhat compressed, 3·5 mm. long with a semi-obovate wing on either side 7·5 mm. long, 2·5 mm. wide, united below the ovary and tapering into the petiole, apex abruptly apiculate, one face furnished with a keel 2 mm. wide decurrent along the united wings, wings and petiole minutely glandular ; ovary 2-celled, placentae 2 in each cell. Ripe *capsule* not seen, young ones with the united wings acute at the base.

Travancore High Range : Kadalaar Valley, 1500 m., in evergreen forest, fls. Sept., *E. Barnes* 1673, 1674 (type in Kew Herb., including material in spirit) ; Nilgiri Hills : Devala, 920 m., fls. Nov., *J. S. Gamble* 15549. Mr. Gamble had named this sheet " B. canarana Miq. ?," and had also written " may be *crenata* or a new sp." It is not in very good condition. The specific epithet commemorates Mrs. Barnes.

Ophiorrhiza Barnesii *C. E. C. Fischer*, sp. nov. [Rubiaceae].

O. caudatae C. E. C. Fischer affinis, sed inflorescentiis axillaribus majoribus, bracteolis linearibus, corollis anguste infundibularibus differt.

A glabrous *herb* ; stem (basal part and root not seen) somewhat woody below, terete, fistular, purplish brown, very young shoots minutely puberulous. *Leaves* lanceolate to ovate-lanceolate, caudate acuminate, base tapered and more or less decurrent on the petiole, often slightly asymmetric, 6·5–13 cm. long, 2–4 cm. wide, dark green above, paler below, lateral nerves 6–8 pairs, upcurved, anastomosing close to the margins ; petioles 1·5–3 cm. long ; stipules minute, ovate, very early deciduous. *Inflorescence* axillary ; peduncles 2·5–6 cm. long, branches up to 3·5 cm. long in fruit ; bracts at the base of the divisions and bracteoles linear, acuminate,

up to 6 mm. long, 1-nerved, brown when dry ; pedicels up to 1 mm. long in flower, up to 1 cm. long in fruit. *Calyx* with receptacle 2 mm. long, very shortly produced above the ovary, lobes ovate-lanceolate, acute, 1 mm. long. *Corolla* narrowly funnel-shaped, 9·5–10 mm. long, white ; lobes ovate, obtuse, 3·6 mm. long. *Stamens* inserted a little below the middle of the corolla-tube which is white-hairy in that region, included ; filaments filiform 2·5 mm. long ; anthers linear acute, 1·5 mm. long. *Style* slender, 1·5 mm. long ; stigmas ovate, as long as the style, puberulous. *Capsules* narrowly obcordate, 2·5 mm. long, 6 mm. wide, remnants of calyx teeth inconspicuous. *Seeds* minute, brown, more or less quadrate, angled ; testa minutely reticulate.

Travancore High Range : Kalaar Valley, fls. & frt. Sept., *Barnes* 1753, 1754 (type in Kew Herb.).

Anaphalis Barnesii *C. E. C. Fischer*, sp. nov. [Compositae].

Ab *A. Notoniana* DC. caulibus majoribus glabris, foliis minoribus lanceolatis marginibus recurvatis, capitulis paucioribus majoribus, phyllaribus majoribus ovatis vel spathulatis albis recedit.

A *herb* 44–75 cm. high, woody below ; rootlets slender ; stems brown striate, sparsely branched, covered with and, except near the base, almost concealed by the imbricating leaves. *Leaves* sessile, erect and adpressed, sometimes spreading near the base of the stem and of the branches, lanceolate, subacute, 1–1·3 cm. long, 5 mm. wide, margins folded back, greyish-tomentose on both sides. *Inflorescence* terminal, corymbose, densely buff-felted, partial main peduncles up to 2·5 cm. long. *Capitula* sessile or on peduncles up to 6 mm. long, broadly campanulate, 6–10 mm. diam. *Phyllaries* 5–6-seriate, 5–6 mm. long ; the outermost ovate, densely long-silky-tomentose on the back, the median lower half rigid, convex and brown on the back, the fringed margins and apex scarious, white, acute ; innermost spathulate, obtuse or subacute, basal half rigid, white with a median brown stripe, apical half scarious, entire, white usually with greenish or olivaceous markings, glabrous except for a patch of long hairs at about the middle of the back ; intermediate in shape and texture passing from the outer to the inner. *Corolla* 2·5 m. long, yellow, 4-toothed ; tube of ♀ florets slender, slightly swollen at the base and slightly expanded at the mouth, teeth lanceolate, short, acute, more or less covered outside with minute yellow glands. *Staminal* filaments short, anthers 1·5 mm. long, tails fringed, tips acute and frequently black-hairy. *Style*-arms 2, truncate, more or less hairy. ♀ *florets* similar but more slender, not swollen at the base and without stamens. *Achenes* narrowly oblong, apex truncate, glabrous, faintly and bluntly 4-angled, 1·5 mm. long. *Pappus* scanty, white, ascendingly barbellate.

Travancore High Range : fls. & frt. Sept., *Barnes* 1703, 1704 (type in Kew Herb.).

Senecio Mayurii *C. E. C. Fischer*, sp. nov. [Compositae].

S. Grahami Hook. f. et *S. belgaumensi* C. B. Clarke peraffinis, sed ab ambobus caulibus indumento floccoso, foliis angustioribus venis paucioribus, phyllaribus scariosis marginatis, ligulis brevioribus, praeterea ab hac pappo praesente differt.

An *undershrub*; stem flexuous, brown-floccose in the middle part, becoming glabrous, cobwebby upwards; roots and base of stem not seen. *Leaves* alternate, lanceolate, coarsely dentate or lobulate, sometimes with a deeply cut narrowly lanceolate lobe at the base on one or both sides, teeth and lobes apiculate with smaller marginal apiculate teeth, acute or acuminate, base tapered into the petiole, the uppermost sometimes sessile with a broad, acutely and deeply lobed auricle, 2·5–6 cm. long, 8–22 mm. wide, lateral nerves 3 pairs, more if there are basal lobes, ascending at a very sharp angle from the midrib, forking outwards, each branch running into a lobe or tooth, dark-brown when dry, above with scattered multicellular hairs, white-cottony below with the prominent midrib and lateral nerves brown; petioles slender, 6–15 mm. long, more or less brown-hairy. *Capitulum* campanulate, in small dichotomous cymes from the upper axils and terminating the branchlets up to 4 cm. long; bracts at the forks linear, up to 2·5 cm. long, brown-puberulous above, cottony below; ultimate peduncles slender, up to 2·5 cm. long, white- or brown-puberulous, bearing usually several slender, linear puberulous bracteoles up to 7 mm. long. *Phyllaries* about 20 in 2 series, linear to linear-oblanceolate, finely acuminate, 2·7–4 mm. long, up to 1 mm. wide, dark-brown (when dry) with a narrow or broad pale-brown, scarious margin, the dark portion bearing rather thick brownish hairs on the back. *Receptacle* pitted. *Ligulate florets* about as many as the phyllaries, up to 7 mm. long; ovary linear, sparingly pubescent, 1 mm. long; pappus of a few ascendingly barbellate brownish-white bristles up to 1·7 mm. long; ligules narrowly oblong, 4–5-veined, 3-toothed, yellow, puberulous without; style 0. *Disk florets* numerous, 2·8–3 mm. long; ovary and pappus as in the ligulate florets but the pappus more ample and longer. *Corolla* cylindric, very slightly widened to the apex, yellow, puberulous without, rather densely so on the 5 short, bluntly triangular teeth; anthers short, obtuse, muticous; style-arms short, truncate. *Achenes* narrowly oblong, slightly widened to the apex, terete or slightly compressed, 1·9 mm. long, 8-ribbed, ribs bearing short bristles; pappus a little longer than the achene.

Mysore State: Kemmangandi Hills, fls. and frt. Nov., *P. V. Mayuranathan* (type in Kew Herb., co-type in Madras Museum).

I have much pleasure in naming this plant after the finder, my friend Mr. P. V. Mayuranathan, Botanical Curator at the Madras Museum, who has done much to improve the knowledge of the S. Indian flora.

Mimulus nepalensis *Benth.* [Scrophulariaceae].

(Nepal to Assam, Japan.)

Travancore High Range : Mannavan Shola in Marsh, 1850 m., fls. Sept., *Barnes* 1671, 1672. The specimens of Professor Barnes differ from the typical ones only in the leaves being rather broader, i.e. broadly ovate to subcircular, 9–16 mm. long, 7–15 mm. wide.

Didymocarpus Humboldtiana *Gardn.* var. **recedens** *C. B. Clarke* [Gesneriaceae].

(Ceylon.)

Travancore High Range : Periakanal at foot of rocks, fls. & frt. Sept., *Barnes* 1697.

Pholidota pallida *Lindl.* [Orchidaceae].

In the Fl. Brit. Ind. this species was united with *P. imbricata* Lindl. but there are good grounds, as pointed out to me by Mr. V. S. Summerhayes, for considering the two as separate species. It is the first only and not the latter that is found in S. India. It is not very easy to distinguish between the two with herbarium material but the distinctions are readily apparent in living plants. *P. pallida* has dark-green, ovate, tapering pseudobulbs, stiffly coriaceous, dark-green, obovate to oblanceolate leaves, flowers not regularly imbricate and appearing about September. *P. imbricata* has pale-green, subcylindric pseudobulbs distinctly truncate at the apex, its leaves are less coriaceous and paler green, more elongate, oblanceolate with a tapered apex, the flowers are regularly and closely distichous and appear about June, the scape is flat though sometimes somewhat twisted.

Cephalostachyum pergracile *Munro* [Gramineae].

(Chota Nagpur, Assam, Burma).

Rampa Agency, Pamuleru Valley, fls. Dec. *R. B. Cornwell* 5252.

XXX—MISCELLANEOUS NOTES.

The Herbert Medal.—Dr. J. Hutchinson has been awarded the Herbert Medal of the American Amaryllis Society for 1939, for his "Services in the systematic botanical treatment of the Amaryllis family and related subjects, and especially for his far-sighted phylogenetic understanding of the fundamentals of these interesting plants, which has been an inspiration to other workers in the field."

Appointments in the Colonial Agricultural and Forestry Services.—We learn with interest of the following appointments : Mr. R. Johns, Agricultural Officer, Zanzibar, to be Agricultural Officer, Fiji ; Mr. A. F. Nichols, Assistant Director of Agriculture, Seychelles, to be Director of Agriculture ; Mr. W. M. Robertson, Conservator of Forests, Sierra Leone, to be Conservator of Forests, Tanganyika Territory ; Mr. R. O. Williams, Chief Horticultural Officer, Palestine, to be Deputy Director of Agriculture, Trinidad and Tobago.

Ernest George Salt Brown.—The untimely death of Dr. E. G. S. Brown, B.Sc., Ph.D., on 5th April 1939, came as a great shock to his colleagues in the Herbarium. Brown, who was Temporary Botanist in the Herbarium, had been on sick leave since early in January on account of the state of his heart. His health, however, had improved considerably by early in April and he was hoping to be able to return to work early in May, when a sudden heart attack proved fatal.

Brown was a Scotsman and was born in Edinburgh on 31st January 1910. He was educated at Broxburn High School, Skerry's College, Edinburgh and the University of Edinburgh. He graduated B.Sc. with First Class Honours in Botany in 1934 and was awarded a Baxter Natural Science Scholarship in the same year. Two years later Brown obtained his Ph.D., his thesis for this degree dealing with the floral development of various genera of the *Theaceae*.

Whilst his studies at the University were principally morphological, Brown spent considerable time working in the Herbarium of the Royal Botanic Garden, Edinburgh. After obtaining his Ph.D. he acted both as Demonstrator in Botany at the University and as a part-time assistant in the Herbarium, where he gained considerable knowledge of the routine methods employed.

In 1937 Brown was appointed Temporary Botanist at the Royal Botanic Gardens, Kew, and he took up his new duties in the Herbarium on 28th June. His time at Kew was occupied with routine work on tropical African phanerogams, including the identifications of current collections.

Brown was a careful worker and quickly gained a knowledge of the groups on which he worked. The nature of the appointment he held did not allow of his devoting official time to research, yet, being keen to attempt some taxonomic work, he had devoted much time to revising the genus *Harrisonia* A. Juss.

Brown's loss has been greatly felt at Kew both by his colleagues in the Herbarium and by his friends at the tennis club, of which he was a keen member.

John Charles Williams.—British horticulture has lost a notable personality by the death of Mr. J. C. Williams, which occurred at Caerhays Castle on 28th March ; and especially does that apply to those interested particularly in rhododendrons. Caerhays is situated on the south coast of Cornwall, where the climate is very mild and the rainfall generous, and it is unlikely that there is in the British Isles a locality with conditions better suited for the cultivation of rhododendrons. It was fortunate for English gardening that Caerhays was owned by so enthusiastic a collector and so capable a cultivator. The explorations of Wilson, Forrest, Kingdon Ward and others inaugurated an entirely new era in rhododendron culture in this country, and no-one took advantage

of the new opportunities more eagerly and more successfully than Mr. Williams.

It would nevertheless be erroneous to infer that the horticultural interest of Caerhays centred solely in its rhododendrons. Mr. Williams was as keenly interested in many other genera. The Asiatic species of *Magnolia* there, for instance, are probably more numerous—certainly, taken altogether, they are finer—than in any other property in the British Isles. He was also much attracted by species of *Styrax*, *Enkianthus*, *Erica*, evergreen *Quercus*, *Fuchsia* and *Camellia*, besides being an enthusiastic breeder of daffodils.

One cannot visit Caerhays without being impressed not only by the health and vigour of its vegetation but also by its high quality. This is due to the severe selectiveness of its late owner ; for anything inferior, no matter what its origin or credentials, was rooted out.

In what one may term ordinary gardening such as bedding, rock gardening, herbaceous borders, pergolas and so on, Mr. Williams took little or no interest ; in fact he was rather contemptuous towards some of these items. Like many another forceful character, he had strong likes and dislikes in other things besides plants.

He was born in 1861 and was educated at Rugby and Trinity Hall, Cambridge. He succeeded to the Caerhays estate on the death of his father in 1880 and soon began to take an active part in Cornish affairs. He was High Sheriff of the County in 1888, joined the County Council the following year, and was a member of Parliament from 1892 to 1895. From 1918 until 1936 he was Lord-Lieutenant of Cornwall.

One very attractive side of Mr. Williams's character was his generosity. If he possessed a good thing in plant life the last of his wishes would be to keep it exclusively for Caerhays. Kew has had much to thank him for ; many of the rhododendrons in the Temperate House and Rhododendron House were presented by him.

W. J. BEAN.

A New Species of Carex.—Carex streptorrhampha *Nelmes*, sp. nov. ; affinis *C. agglomeratae* C. B. Clarke, sed foliis et bracteis inflorescentiam longe superantibus, bracteis longe vaginantibus, spica terminali omnino mascula, spicis femineis longioribus et subfastigiatis, pedunculis longioribus praecipue differt.

Culmi laxe caespitosi, 21-23 cm. alti, subvalidi, triquetri, glabri, foliati, basi vaginis aphyllis purpureo-brunneis vestiti. *Folia* 3 mm. lata, marginibus revoluta, scabrida, superiora inflorescentiam longe superantia, longe vaginantia ; vaginae rubro-brunneae, demum reticulatim fissae. *Spicae* 7–8, subfastigiatae, superiores sessiles vel breviter pedunculatae, inferiores 1 vel 2 parum distantes et longius pedunculatae, bracteatae ; mascula lineari-cylindrica, 1·5–2 cm. longa ; laterales femineae, plerumque 1·5–2 cm. longae, oblongae, subdensiflorae. *Bracteae* foliaceae, inflorescentiam longe superantes, longe vaginantes. *Squamae* femineae ovato-lanceolatae,

inferne albescenti-hyalinae, superne brunnescentes, marginibus late albescenti-hyalinae, obtusae, carinatae, carina in mucronem sublongum leviter scabrum excurrente. *Utriculi* 3–4 mm. longi, squamis leviter longiores et latiores, stramineo-virides, suberecti, trigoni, ovoidei, distincte marginati, dense punctulati, enerves sed basi obsolete nervosi et contracti, in rostrum mediocre teres brunneum demum oblique curvatum et interdum leviter tortum ore albescenti-hyalinum subintegrum subabrupte abeuntes. *Nux* arcte inclusa, obovata, trigona, lateribus concavis, dense papillosa, stipitata, rostrata, stipite et rostro leviter torto-curvato. *Stylus* basi incrassatus. *Stigmata* 3.

Burma-Tibet Frontier. Adung Valley, 28° 20′ N., 97° 40′ E., sources of the Irrawaddy, open grassy places along the river bank and by streams, 2400-3000 m., 6 June, 1931, *F. Kingdon Ward* 9598 (typus in Herb. Mus. Brit.).

Plant and Animal Communities.—The growth of ecology in the past three decades has been phenomenal and has resulted in the publication of an overwhelming number of books, journals, and scattered papers. It is impossible for anyone who is not specializing in ecology to keep abreast with the wealth of ideas, concepts, and terms which are based sometimes upon detailed field studies and sometimes, one is inclined to think, upon considerations from a study arm-chair. Nevertheless, no biologist who wishes to avoid becoming a narrow specialist can afford to neglect the main developments of ecology. For this reason there should be a wide welcome for the Proceedings of the Conference on Plant and Animal Communities, held at the Biological Laboratory, Cold Spring Harbour, Long Island, New York, from August 29 to September 2, 1938, and published in the American Midland Naturalist, **21**, 1–255, January 1939. In the Proceedings, ten papers are published in full and the discussions are given at the end of the papers to which they referred. How far the discussions were edited is not stated but they keep remarkably well to the subject-matter of the paper which they often elucidate considerably. Useful lists of references are appended to the papers. The papers deal with a variety of ecological subjects: botanical, zoological, biological, and sociological, and all repay serious reading.

H. S. Conrad is obviously a pragmatist, and the introductory remarks to his paper "Plant Associations on Land" can be applied with advantage to other subjects than ecology. He very concisely outlines the principal standpoints of the main schools of ecology. He points out that these have been greatly influenced by the nature of the communities studied, that is by the communities characteristic of the country in which the "school" is situated. To discuss just why there is no British "School" of ecology might lead us into a study of national psychology. Conrad quite definitely accepts associations of plants on land as definable entities, susceptible of naming and classifying.

G. E. MacGintie and F. E. Eggleton deal respectively with Littoral Marine Communities and Fresh-Water Communities, both from the zoological standpoint. J. R. Carpenter discusses The Biome, and concludes that " the concept that the community is an organism, while perhaps a useful adjunct, is not essential to the acceptance of the concept of the biome as expressing a living dynamic ecosystem of living organisms, dependent in its climax stages not upon the habitat but upon climate."

The most controversial paper is that by H. A. Gleason on The Individualistic Concept of the Plant Association. His thesis is summarized as follows: " environment varies constantly in time and continuously in space; environment selects from all available immigrants those species which constitute the present vegetation, and as a result vegetation varies constantly in time and continuously in space." It is quite obvious from the context that Gleason does not mean his conclusion to be taken too literally and some of his explanations or elaborations of possible objections tone down very considerably the bald statement just quoted. Gleason does emphasize one very important matter often ignored by ecologists: that only those species can immigrate into an area (or a community) whose disseminules are available within migrating distance. There are several corollaries of this truism that are of importance both in ecology and phytogeography and would repay detailed investigation.

T. Lippmaa in his paper on The Unistratal Concept of Plant Communities (the Unions) considers, in some detail, the advantages of intensive and extensive studies of a single " union," i.e. a community occupying only one height stratum of the aerial parts. He pays particular attention to the *Galeobdolon—Asperula—Asarum* union of the large-leaved deciduous forest of Eurasia. His paper leads to discussion of many matters of general interest, as, for example, the value of phytogeographical research to ecologists and the influence of the Ice Age on European vegetation.

S. A. Cain discusses the Climax and its Complexities. He accepts the view that Clements's climaxes and associations are physiognomic-floristic groups of undoubted verity. He considers that Clements's scheme, including its latest modifications and extensions, presents a scientifically and philosophically sound system. Certain objections to the all-inclusiveness of the Clementian system are answered, but several others are merely stated and not refuted except in vague general terms. While, for example, it may be true that " most of the differences between the adherents of the monoclimax hypothesis and the polyclimax hypothesis are differences of *terminology*," it seems evident that attention should be given to community differences that do not fit into the monoclimax scheme other than by the mere manufacture of a new subordinate term.

The last three papers are sociological, in one or other sense, and not primarily of botanical interest.

In conclusion, a doubt may be expressed regarding the value of manufacturing quite so many terms to express grades, kinds, and groupings of plant communities. Sometimes Latin and Greek are used, sometimes vernacular words are given a (more or less) scientific definition. That a minimum number of terms is an essential for progress in any science is generally agreed, but a similar tendency is ascertainable in ecology to that which has long been a bane in taxonomy—that to give a name to a community (a group or a phenomenon) so that it can be pigeon-holed is the most important thing to do with it. One other criticism may be made and is applicable not only to the Conference here noticed but also to much recent ecological work. Synecology is developing at great speed but autecology is being relegated to the background. This appears to the present writer to be extremely unfortunate for it is difficult to believe that the structure and development of a plant community can be properly understood until the life histories of the constituent species have been investigated. W. B. TURRILL.

The Structure of Economic Plants.*—In the past the majority of books on plant anatomy have been written so as to present the facts, which might in themselves be very dull, against a phylogenetic background. Others have dealt with structure in relation to physiological function, whilst a third category includes those which are designed to aid the microscopist to identify botanical material. The book now under review, which is based on courses in plant anatomy given at the University of Chicago, falls into a different class from any of those mentioned above. After beginning with a general introduction to plant anatomy, it deals mainly with the structure of a selection of herbaceous economic crop plants at all stages of their development from the seedling to the mature plant. For many of the plants, particulars of floral and seed development and structure are included, and sometimes embryological details as well. This well-written book, in which a great deal of recent but scattered information has been brought together and summarized, should be welcomed by agricultural students and research workers who require information concerning the structure of the crop plants in which they are interested. A valuable feature is the large number of excellent line drawings, on which very considerable care has evidently been expended. It is to be regretted, however, that the general high standard of the illustrations has been marred by those on pp. 493 and 501. The book ends with a glossary of anatomical terms followed by a general index. It is stated in the Preface that the preparation of a companion volume on similar lines dealing with important fruit crops is contemplated. The appearance of this will be awaited with interest. C. R. METCALFE.

* By Herman E. Hayward. The Macmillan Co., New York, 1938. Pp. x+674, figs. 340. Price 22*s*.

Poisonous Plants of the United States.*—As poisonous plants are of such vital importance to mankind, not only in animal husbandry, but in other spheres, it is gratifying to record the appearance of an up-to-date and comprehensive work on this subject. It is now nearly thirty years since Pammel's well known " Manual of Poisonous Plants "—also an American publication—appeared, and during this time great advances have been made concerning poisonous plants, especially those that are harmful in the livestock industries of important pastoral countries such as the Americas, Australia, New Zealand and southern Africa. The author's aim has been to bring together in concise form, the results of work of this kind in so far as his own country is concerned.

As the title indicates this book deals only with poisonous plants occurring in the United States. Introduced as well as native plants are dealt with. Many of these are well known in other countries, either in a wild, naturalised or cultivated state. Examples are *Abrus precatorius, Buxus sempervirens, Cannabis sativa, Colchicum autumnale, Datura Stramonium, Equisetum* spp., *Hypericum perforatum, Lychnis (Agrostemma) Githago, Melia Azedarach, Nerium Oleander, Phytolacca americana, Pteridium latiusculum* (Bracken), *Rhus Toxicodendron, Ricinus communis, Sorghum* spp., and *Tribulus terrestris*. From this it is apparent the sphere of usefulness of the work will not be confined to the United States. Furthermore, it contains a good deal of fundamental material of interest to any student of poisonous or injurious plants.

The book is divided into two parts, the first being devoted to a brief and general consideration of the nature of poisonous plants, while the second and more extensive part consists of a detailed treatment of the various species. In the first part, under " plants poisonous or injurious under special conditions," the subject matter is classified under the following headings—plants causing dermatitis; plants causing photosensitization ; cyanogenetic plants ; introduced poisonous ornamental plants ; plants producing poisonous seeds ; seleniferous plants ; plants causing mechanical injury ; and those causing undesirable flavours in milk and milk products.

The investigations on seleniferous plants that have been carried out during the last decade in the United States no doubt constitute one of the most interesting phases of work on poisonous plants in recent years. The author briefly outlines the results of this work and gives a list of species known to be made poisonous by selenium absorbed from the soil. Maladies such as " alkali disease " and " blind staggers " in cattle and horses have now been traced to selenium in the vegetation, the first mentioned being a disease caused through eating small amounts of selenium-bearing vegetation over a long period and the latter through feeding on relatively large amounts of selenium in a short time. The writer states—" The

* By W. C. Menscher. The Macmillan Company, New York, 1939. Pp. 266, figs. 75. Price 15*s*.

selenium content of plants growing on soils rich in selenium compounds, such as certain Cretaceous or Eocene shales, may vary greatly. Some species seem always to contain selenium while others may or may not absorb it. According to Beath and his associates, selenium absorbed from seleniferous shales by certain plants is returned to the soil upon their death and decomposition and becomes available to other native species and even to some crop plants that are unable to absorb inorganic selenium from seleniferous soils directly. By this process, plants ordinarily harmless, through the aid of certain " converter " plants, might become poisonous.

In the second or main part of the work the species are arranged according to families (Engler's system). For each species the common names and a general description are given. This is followed by information under the categories of distribution and habitat; poisonous principle; conditions of poisoning; and symptoms and treatment (where known).

The book is written by the same author, and is on similar general lines to one entitled " Weeds " which appeared a few years ago (K.B. 1935, 585). Numerous excellent full page line drawings and a good bibliography are included. F. N. HOWES.

Floral Morphology.*—The first volume of this work was published in 1937 and reviewed in K.B. 1937, 400. The second volume is much larger (and correspondingly higher in price). The pagination continues from the first volume.

It may be recalled that in the first volume, after a useful, but too brief, general introduction, the author outlines the floral morphology of a selected number of families, with details of illustrative types for every one. The arrangement of the 39 families treated, and the selection of " illustrative types," was largely based upon the general aim of the book " to serve as a guide to the study of types in the laboratory." It was not intended that the professional taxonomist should use the book as a work of reference. The second volume is, in result, more ambitious, since it brings the number of families considered up to 190 and thus includes many not studied in the laboratory by the vast majority of students. An adequate index to both volumes should increase their general usefulness considerably. Volume one was meagrely illustrated. More figures are given in the second volume and these include a number referring to families dealt with in the first volume.

As the subtitle of the work indicates, special reference is given to the interpretation of the gynoecium (gynaeceum). Miss Saunders's investigations of flower structure, and particularly of the vascular supply to the gynoecium and other flower parts, in a wide

*" Floral Morphology, a New Outlook with Special Reference to the Interpretation of the Gynaeceum," by E. R. Saunders, F.L.S. Volume two. W. Heffer & Sons, Ltd., Cambridge, 1939. Pp. xiv+609,+vii. Price 10*s.* 6*d.* net.

range of Angiosperms are well known. She has, in numerous papers in the Annals of Botany, the New Phytologist, and elsewhere, produced a mass of (mainly) anatomical evidence which she interprets as uniformly in favour of the theory that the syncarpous gynoecium is composed of valve and consolidated (the latter including solid and semi-solid or pseudo-valve) carpels. There is no doubt that the data given in detail in Miss Saunders's papers and summarized in the two volumes of "Floral Morphology," require very careful consideration by taxonomists. She claims that the general principles adopted "serve to bring the known facts into line so that they constitute a co-ordinated whole" and that "they dispose of many morphological fictions." That there are "morphological fictions" is certain and there is considerable justification for the claim that Miss Saunders's general principles and detailed interpretations give them a very suggestive and often new explanation. On the other hand, there seems to be little agreement at present among those who have specialized in floral anatomy as to the morphological interpretation of floral parts. Perhaps "Floral Morphology" will bring them into line, or, alternatively, will give them an excuse to mass their batteries to destroy Miss Saunders's imposing attack on orthodoxy and, incidentally, on various heterodoxies.

The working taxonomist is usually not a specialist in floral anatomy. He may, however, question whether Miss Saunders does not over-stress the value of vascular bundles as indicating the number and organization of carpels in a syncarpous gynoecium. A very great deal of the description of flower structure in the two volumes of "Floral Morphology" is in orthodox terms. The taxonomist is concerned primarily with determination, description, and classification on the basis of correlation of characters (coherence of attributes). Miss Saunders's work should make him overhaul his descriptive terms and replace by neutral terms those which are not merely descriptive but by original meaning assume the acceptance of some morphological theory. Such terms are often used without the intentional acceptance of the "explanatory" theory. To say that the ovary of *Tulipa Gesneriana* is trilocular is better description than to say it is tricarpellary, apart from the fact that, according to Miss Saunders, the latter statement is incorrect.

The writer expresses the hope that Miss Saunders will follow up her detailed, and mainly descriptive, work with a synthesis of her views on floral evolution. Acceptance of the theory of carpel polymorphism must surely lead to a classification of taxonomic units different from that in any of the published classifications. It must also have a very considerable bearing upon the problems of divergence, convergence, "parallelism," and reticulation, which the systematist so often meets and which need a thorough investigation from modern standpoints, whether heterodox or more or less orthodox.

W. B. TURRILL.

Wall Shrubs and Hardy Climbers.*—Mr. Bean's latest volume may be described as a companion to his "Shrubs for Amateurs" and "Trees for Amateurs."

In selecting his material, Mr. Bean has interpreted his title in its very widest sense, so as to include not only ordinary climbing plants but also any shrubs which can as a rule be grown better against a wall than in the open shrub border. *Daphne odora* is an example.

The first 24 pages deal with cultivation, methods of support, pruning, and lists of various types of climbers and wall shrubs. The remainder of the book is devoted to a "Descriptive List of Climbers and Wall Shrubs," in alphabetical order. There are 47 full page illustrations depicting a wide variety of plants suitable for the purpose in view.

Most garden lovers are collectors of books dealing with gardening. Their shelves will be crowded already, but this is certainly a volume for which space must be found. A. OSBORN.

HENRI CORREVON.—We record with regret the death, on May 11th 1939, of the veteran Swiss horticulturist and botanist, M. Henri Correvon, at the age of 84 at Hérisau, Canton Appanzell, where he was undergoing an operation.

M. Correvon was for many years a valued correspondent of Kew and contributed rare and interesting specimens of alpine plants to our collections. He was a renowned cultivator of alpine plants, of which he had an extensive knowledge. His book on "Rock Garden and Alpine Plants" embodied much of his wide knowledge, and the results of his skill in their cultivation were collected together in his now famous garden at Chêne-Bourg, which he established in 1902 after his earlier garden in Vaud had been destroyed by a severe hailstorm.

One of M. Correvon's chief interests was the establishment of mountain gardens for alpine plants. In 1885 he constructed a small rock garden at an elevation of 6000 feet in the Val d'Anniviers, and later he established a similar garden above Bourg-Saint-Pierre. These gardens have inspired similar ventures in other parts of Switzerland and in other countries.

M. Correvon was an ardent champion of the protection of the wild flora of Switzerland, and a committee of the Swiss Alpine Club, formed by him, developed into the international organisation known as Naturschütz. His views on this subject were far-sighted and he insisted that an important means of checking the decimation of the flora was the cultivation of rare alpine plants for sale to the public, a policy which he himself did much to put into practice.

M. Correvon had many friends in this country, and his loss will be mourned by all lovers of alpine plants.

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*By W. J. Bean, C.V.O., I.S.O., V.M.H. Putnam, London, 1939. Pp. xii+182, illustrated. Price 7*s.* 6*d.*

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